Carlo Bertoldi[1], Marco Venuta[2], Gianpaolo Guaraldi[3], Michele Lalla[4], Stefania Guaitolini[5], Luigi Generali[1], Daniele Monzani[6], Pierpaolo Cortellini[7], Davide Zaffe[8]

Are periodontal outcomes affected by personality patterns? A 18-month follow-up study.

Running title: Personality in periodontal therapeutics.

Key words: Personality cluster; Anxiety; Depression; Oral hygiene; Periodontal treatment;

[1]MD, DDS. Department of Surgery, Medicine, Dentistry and Morphological Sciences with Transplant Surgery, Oncology and Regenerative Medicine Relevance, University of Modena and Reggio Emilia, Modena, Italy

[2]MD. Department of Diagnostics, Clinical and Public Health, University of Modena and Reggio Emilia, Modena, Italy

[3]MD. Department of Diagnostics, Clinical and Public Health, University of Modena and Reggio Emilia, Modena, Italy

[4]MPhys. Department of Economy “Marco Biagi”, University of Modena and Reggio Emilia, Modena, Italy

[5]DDS. Private Practice, Modena Italy - stefania_guaitolini@hotmail.it

[6]MD. Department of Diagnostics, Clinical and Public Health, University of Modena and Reggio Emilia, Modena, Italy

[7]MD, DDS. Private Practice, Firenze Italy

[8]MBioSc. Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia, Modena, Italy

Corresponding author: Prof. Davide Zaffe, Dipartimento di Scienze Biomediche, Metaboliche e Neuroscienze, Università di Modena e Reggio Emilia, Via del Pozzo 71, 41124, Modena, Italy. E-mail: davide.zaffe@unimore.it; Phone:++39 0594224804 - Fax: ++39 0594224861

Abstract

Objectives: This research aims to study the relationship between personality traits and periodontal clinical outcomes by taking into account the level of anxiety and depression, periodontal health, and oral hygiene behavior of patients affected with gingivitis or moderate periodontitis requiring periodontal therapy.

Material and Methods: The periodontal data of 40 systemically healthy patients affected by gingivitis or moderate periodontitis were collected at baseline and 18 months later. The psychological variables, dental awareness and adherence intent of the patients were assessed through questionnaires, and only those patients that exhibited a higher degree of compliance were included in the study. The personality traits (cluster A: paranoid, schizoid, schizotypal; cluster B: borderline, antisocial, narcissistic, and histrionic; cluster C: avoidant, dependent, and obsessive-compulsive) and the level of anxiety and depression of the patients were assessed. Patients were instructed with oral hygiene measures and were treated with periodontal therapy.

Results: Clusters A and B showed a consistent tendency for reduced levels of oral hygiene (increased full-mouth plaque score - FMPS). The results from cluster B were found to be significantly related to deep periodontal pockets at baseline. On the contrary, cluster C seemed to be linked to clinically better indices, particularly in terms of full-mouth-bleeding-score and pocket depth, both at baseline and 18 months later. The results collected from clusters B and C were directly correlated with anxiety, depression and FMPS. Moreover, anxiety was directly correlated with the patient's need for professional oral-care.

Conclusions: Personality traits appear to play a significant role in determining the therapeutic outcomes of periodontal therapy in themselves. Thus, it is ideal for several

important psychological, affective, or behavioral factors to be associated with various personality traits so as to orient the outcome of periodontal therapy.

Introduction

The clinical expression of periodontal varies per patients [1,2]. Epidemiological studies showed that patients with risk conditions develop more severe periodontal disease [2]. Periodontitis is the concurrence of bacterial infection and host inflammatory and immune responses, which may play either a protective or a destructive role [3,4]. Previous studies showed that environmental risk factors, such as smoking, uncontrolled diabetes mellitus, or nutrition may change the host response and consequently modify the disease progression, severity, and outcome [1-5].

Other factors, such as psychological factors, are not yet confirmed as substantial risk conditions or even as potential factors that can influence the development of periodontal disease [2, 6-8]. The biological foundation for such association is supported by some studies demonstrating that psychological conditions, such as depression or exposure to stress factors, could modify the immune response, and enhance the susceptibility of a person to develop unhealthy conditions, including periodontitis [7,9]. Numerous treatment failures in periodontology could be attributed to the absence of oral hygiene basics such as regular tooth brushing and dental checkups [10]. Educational models based on a biopsychosocial perspective could have a potential to influence an individual's capacity to maintain long-term oral hygiene control [11,12]. A series of studies, which are largely randomized controlled trials, analyzed psychological interventions through several psychological frameworks and clinical markers of periodontal disease, and it was found that those interventions seemed to be effective in creating behavioral changes irrespective of the theoretical framework under which they had been subjected to [10,11,13].

The routine clinical application of such social cognition models; as added value to behavioral change interventions, is still at its beginning, and there are relatively few published studies with reference to dental care [10]. Psychologists have identified health

education and oral hygiene behavior as interesting targets for therapeutic behavioral change, given the universality and central role of behavior in maintaining oral health [12,14]. Furthermore, health education could influence behavioral beliefs and related attitudes [14]. Oral hygiene behavioral aptitude depends on several elements, and it seems to involve our innermost being [12]. The detection of psychological states seems to be a focal point as it may produce more effective results on periodontal treatment rather than a standard treatment.

The relationship between periodontal health and affective states has been investigated in a few cross-sectional or case-control studies [7-9,15] and prospective studies [16~~9~~, 17]. However, the correlation between periodontal therapy conditions and personality traits has not yet been exhaustively studied. These studies analyzed personality traits in relation to patient compliance; and the differences in the personalities of compliers versus noncompliers were found, but these were not statistically significant [18,19]. Conversely, the literature on periodontal therapy lacks studies evaluating personality traits [19], and additional researches are necessary to isolate personality factors in relation to periodontal therapy [20]. Furthermore, the correlation between personality traits and adherence to treatment and behavioral responses has not yet been completely proven [10,18,19].

Understanding patient personality traits would be advantageous for the clinician [20]. The method of predicting health behaviors while exploring personality factors influencing such behavioral responses may offer the optimum strategy in predicting and potentially circumventing noncompliance to periodontal maintenance [20].

The aim of this prospective longitudinal study is to verify the relationship between personality traits and periodontal clinical outcomes by taking into account the levels of anxiety and depression and oral hygiene behaviors in compliant patients affected with

gingivitis or moderate periodontitis requiring periodontal therapy.

Materials and methods

Table 1 - Systemic and specific adopted inclusion criteria

Systemic Inclusion Criteria
Absence of relevant medical conditions: Individuals were included if they had a clear medical history and no physical or psychological disorder which could affect their conduct in the study (e.g. psychotic disorders, personality disorders)
Smoking status: non smokers or smokers up to 20 cigarettes a day. Cigar or pipe smokers or people with a story of alcohol abuse were excluded.
Compliance: only patients showing fine levels of compliance (as assessed during the study) were considered [21, 22].
Instruction: only patients having compulsory education were considered
Pregnancy or lactation and underage were excluded.
Local Inclusion Criteria
Oral and periodontal conditions: Absence of premalignant lesion of the oral cavity, rhinopharynx and larynx (as assessed by fibroscopy).
Individuals having lesser than 16 teeth, or wearing removable partial dentures, or showing oral parafunctions, or presenting severe orthodontic abnormalities and/or substantial oral dysmorphism were excluded. Individuals with diagnosis compatible with periodontal disease, at least one phase of steps 1-5, were included. On the contrary, individuals having more than 2 interproximal sites with clinical attach level (CAL) ≥ 6 mm (not on same tooth) and ≥1 interproximal site with probing pocket deep (PPD) ≥ 5 or CAL ≥ 5 mm in ≥ 30% of teeth present after the completion of the second step were also excluded.
Individuals showing a full-mouth plaque score >15% after cause-related therapy were excluded [23]
Treatment history: Individuals who received oral hygiene instructions, or root-planing, or periodontal surgical treatment in the preceding 6 months, or individuals with orthodontic or prosthetic therapy in progress were excluded.
Level of infection: Individuals included did not show large cariogenicity. Individuals were excluded if presenting stomatitis, abscess or gingival fistulae.

Study population and experimental design

The patients were selected from a population of systemically healthy patients that were screened, examined, and treated in a private dental office. Patients were included in the study after a full oral examination. The inclusion criteria of patients are reported in Table 1.

All patients enrolled in the study, according to the inclusion criteria, signed the informed consent form detailing the study procedures that are in line with the 2008 Helsinki protocols and ethical requirements [24].

The study design was scheduled in five steps. The first step consisted of the initial patient evaluation, case history, dental screening visit, treatment motivation, and preliminary treatment after patient's consent [25]. The gingival tissue sanitization was necessary to achieve a predictive periodontal diagnosis, particularly in patients lacking dental supportive therapy or those without regular dental examination for a long period. This step is concerned with the initial hygienic-dental treatment, acute and urgent surgeries, and endodontic and conservative conditions, which all require a short-term solution management to achieve the stabilization of periodontal tissues. The dental belief questionnaire (DBQ) was routinely administered during the first step to better address the patient's treatment [25]. All measurements and adjunctive surgical therapy were performed by one researcher (C.B.). Another researcher designed and monitored the treatment plans (P.C.), whereas the other researcher (S.G) gave the hygienic instructions and performed cause-related therapy.

The second step included the oral (baseline) and psychosocial assessment. The psychological assessment was performed through a clinical interview on personality traits and disorders (APA 2000 - DSM-IV TR-SCID II) [26], self-rating anxiety state (AS), and self-rating depression scale (DS). If all requirements were met, the patient giving his/her own informed consent was enrolled in the study. The third step consisted of the completion of cause-related therapy, including scaling and root planning, and oral-hygiene instructions. The fourth step included additional necessary periodontal therapy [27]. In the fifth step, all patients were included in a supportive periodontal care program with recalls within the 8^{th} and 12^{th} weeks. The fifth step also included the overall assessment of the

treatment after 18 months.

Patients who did not show complete compliance throughout the study or those who no longer met the inclusion criteria, as shown in table 1, even after the study has started, were excluded from the study [28,29]. In addition, patients with severe periodontitis presenting with ≥2 interproximal sites and clinical attachment level (CAL) ≥6mm on different teeth or those patients with ≥1 interproximal site with probing pocket depth (PPD) ≥5mm and CAL ≥5mm in ≥30% of teeth after the completion of the third step were excluded from the study as well [27].

Clinical measures and questionnaires

During the screening phase, the periodontal examination was assessed through periodontal screening and recording (PSR) using the World Health Organization periodontal probe. A complete oral examination was carried out at baseline with a flat rhodium-plating dental mirror, a dental probe, and a periodontal probe (PCP-UNC 15 HuFriedy, Chicago, IL, USA). Full-mouth plaque score (FMPS), full-mouth bleeding score (FMBS), and PPD were assessed at six sites per tooth. PPD values were categorized into three levels: PPD_L (low) = ≤ 3mm; PPD_I (intermediate) = > 3 mm and < 5mm; and PPD_H (high) = ≥ 5mm. The percentage of sites belonging to each level was calculated for each patient, wherein PPD measurements = PPD_L% + PPD_I% + PPD_H% = 100 %.

The following variables were recorded: age, gender, body mass index (BMI) [29], number of teeth present in the oral cavity (NoT), periodontal quality indices, based on the SSO categorization criteria [21,22], biological and structural integrity (BSI), tissue description (TD), patient compliance (PC), and continuing care (CC).

These periodontal indices, which were assessed at the end of the study, were categorized into four levels: excellent (A); acceptable (B); poor quality, capable of

improvement to be acceptable with further therapy (C); unacceptable quality and cannot be improved with periodontal therapy (D). Only levels A and B compliant patients were included in the study.

The DBQ was self-administered to patients, and a health-value scale (HV) and two adherence-intent scales (AI1, AI2) were separately scored [16].

The HV scale aimed at assessing the patients' general knowledge and perception of daily oral home-care. AI1 was related to the self-performed oral home-care behavior, whereas AI2 was associated with the patient's need for professional oral-care. As defined by Borkowska et al. [16] and Schuman and Presser [30], a finite, even number of rating steps, from 1 (strongly disagree) to 6 (strongly agree) was used in the statistical analysis. The score for each item was assigned in direct relation to the appropriateness of the clinical response; and the higher the score of the response is, the better the clinical outcome would be.

The psychological questionnaires and interviews were administered by one expert operator (M.V.). The personality assessment consisted of a structured clinical interview for personality disorders-SCID II to exclude personality disorders and to differentiate the types of personality traits that are commonly present in individuals without personality disorders [26,31]. Personality disorders are characterized by trait combinations with high expression intensity that can strongly affect social lives. The disorders were reported in this step and were considered for excluding patients from the study. To avoid bias, the clinicians were notified of the patients' personality traits at the end of the follow-up.

The personality traits studied in this research and included in the axis II were the following: the AII A or cluster A (paranoid, schizoid, and schizotypal personality traits); AII B or cluster B (borderline, antisocial, narcissistic, and histrionic personality traits); and AII C or cluster C (avoidant, dependent, and obsessive-compulsive personality traits).

The self-rating AS, which was designed similar to a customer service survey questionnaire, aimed to assess the patient's level of anxiety [32,33]. It is a 20-item self-report assessment device that was built to evaluate anxiety levels based on scoring four groups of manifestations: cognitive, autonomic, motor, and central nervous system symptoms. The patients were requested to indicate how much they can relate to each of the statement. The questions were graded as "a little of the time", "some of the time", "good part of the time", and "most of the time". The overall score was then converted into an anxiety index score, which is the clinical interpretation of the anxiety level [32,33].

The self-rating DS, which is a self-administered measure of depression severity, was aimed to evaluate various depressive symptoms [32]. The short, simple, and quantitative scale was intended to be all-inclusive with respect to symptoms. The items were selected to address the affective, cognitive, behavioral, and physiological aspects of depression. Moreover, the higher the score in the scale, the more severe the level of disturbance would be [32]. All psychological interviews were administered to patients using the Italian authorized version by G.G. [31,34].

Study outcomes and data analysis

Data were expressed as mean ± standard deviation (m±SD). The values of 0 and 1 were assigned for males and females, respectively. The study outcomes were: FMPS, FMBS, and PPD, which was split into three levels per patient according to the baseline evaluations. The outcomes were considered as baseline (-b) and end (-e) of the study values. The changes (differential = -d) in these indices were calculated between the baseline and the final assessment, in which FMPS-d = FMPS-b - FMPS-e).

These data were compared with the recorded clinical findings, dental beliefs, and psychological questionnaires outcomes. Periodontal quality indices, namely A, B, C, and

D, were assigned with values 4, 3, 2, and 1, respectively.

Statistical analysis was performed with Stata, version 14.00 [35]. Hypothesis tests on population distributions referred to variables collected at baseline and at 18-month visit. The alpha Cronbach reliability coefficients for each HV and AI1 and AI2 scales were calculated through the item analysis procedure in Stata (alpha command). The comparisons between the initial and final values observed on the two waves (matched data) for the relevant variables were carried out with signed-rank statistics, whereas the comparisons between two independent groups (unmatched data) were carried out through Wilcoxon rank-sum test or the Mann-Whitney test. The Spearman correlation coefficients between variables were calculated and the null hypothesis, which stated that no relationship exists between the pairs of variables, was tested against the alternative hypothesis (two-tailed), which stated that a relationship exists between the variables. Although they have less power than parametric tests, nonparametric tests were applied as they reduce the number of assumptions, which may be untenable and unverifiable in some cases. Moreover, the nonparametric tests were carried out between level. These tests lacked power, but these are the ones usually used in data statistical processing as these tests can still yield significant results. The identified dependent variables were FMPS, FMBS, PPD_L, PPD_I, and PPD_H. The relationships between the dependent and the independent variables were examined through standard multiple regression models, using the stepwise method for the selection of the independent variables. The level of significance of the applied tests was P=0.05.

Results

Forty patients met the inclusion criteria during the five protocol phases and completed the study. All the oral evaluations were performed by only one examiner whose intra-rater

reliability resulted in a good agreement (0.89-1.0) after the Spearman (PPD and PSR) and Pearson (FMPS and FMBS) tests.

Baseline examination

The patient population, which consisted of 29 women and 11 men, with an age of 35.4±13.6 years and showing a normal BMI (22.7±3.2), presented with a mean tooth loss of seven elements (NoT = 25.6±3.1). The baseline clinical data are reported in Figure 1 and Table 2. The mean dental belief parameters of all patients are presented in Table 3, wherein: HV = 43.1±6.4 (range 10-60), AI1 = 62.9±10.1 (range 13-78), and AI2= 8.8±5.2 (2, range 3-18).

The alpha Cronbach's reliability coefficients of HV, AI1, and AI2 were satisfactory: HV = 0.71, AI1 = 0.78, and AI2 = 0.79. The value for HV, although acceptable, is near the critical value. The mean values of personality characterization of patients are reported in table 3, in which 1 = occurrence and 0 = lack of each investigated trait. Out of 40 patients, 30% belonged to AII A (Cluster A), 37.5% belonged to AII B (Cluster B), and 25% belonged to AII C (Cluster C). The calculated anxiety and depression scores were: AS = 32.3±10.6 (range 20-80), and DS = 31.6±10.2 (range 20-80).

Table 2 – Average, Standard deviation (N = 40) and Spearman correlation of systemic / dental indices.

		A	G	BMI	BSI	TD	PC	CC	NoT	FMPS b	FMPS e	FMPS d	FMBS b	FMBS e	FMBS d	PPD_L b	PPD_L e	PPD_L d	PPD_I b	PPD_I e	PPD_I d	PPD_H b	PPD_H e	PPD_H d
m		35.4	-	22.7	-	-	-	-	25.6	34.3	23.9	10.3	34.1	18.8	15.3	69.4	93.1	- 23.7	22.9	6.8	16.1	7.7	0.1	7.6
SD		13.6	-	3.2	-	-	-	-	3.1	15.5	14.1	9.5	12.9	9.8	11.6	21.1	3.8	19.7	15.4	3.7	14.3	6.4	0.3	6.3
BSI																								
TD																								
PC					0.4																			
CC							0.7																	
NoT			- 0.6		0.4																			
FMPS	b			0.4	- 0.4		- 0.5	- 0.5	- 0.3															
	e			0.3	- 0.5		- 0.7	- 0.6	- 0.5	0.8														
	d									0.4														
FMBS	b					0.5																		
	e				- 0.5		- 0.4	- 0.6		0.5	0.6		0.6											
	d					0.6		0.4		- 0.3	- 0.4		0.6											
PPD_L	b			- 0.5	0.5		0.5	0.4	0.3	- 0.5	- 0.5			- 0.4	0.5									
	e				0.3	0.6	0.4				- 0.3				0.4	0.4								
	d			- 0.5	0.4		0.4	0.3	0.3	- 0.4	- 0.4			- 0.3	0.4	1.0								
PPD_I	b			0.5	- 0.4	- 0.3	- 0.4		- 0.3	0.4	0.4				- 0.5	- 1.0	- 0.3	- 1.0						
	e				- 0.3	- 0.6	- 0.4				0.4	- 0.3	- 0.3		- 0.4	- 0.4	- 1.0		0.3					
	d			0.4	- 0.3		- 0.3		- 0.3	0.3	0.3				- 0.4	- 0.9		- 1.0	1.0					
PPD_H	b			0.5	- 0.6	- 0.3	- 0.5	- 0.4		0.5	0.5			0.4	- 0.4	- 0.9	- 0.4	- 0.9	0.8	0.4	0.8			
	e				- 0.4	- 0.5			- 0.4				- 0.5		- 0.5	- 0.4	- 0.6	- 0.4	0.4	0.6	0.4	0.5		
	d			0.5	- 0.6		- 0.5	- 0.4		0.5	0.5			0.4	- 0.4	- 0.9	- 0.4	- 0.9	0.8	0.4	0.8	1.0	0.5	

Direct and inverse (-) correlations of periodontal quality-dental indices (left) versus systemic-dental indices (corresponding rows). b = baseline; e = ending; d = differential (b - e).

A = Age; BMI = Body Mass Index; BSI = Biological and Structural Integrity; CC = Continuing Care; FMBS = Full-Mouth Bleeding Score; FMPS = Full-Mouth Plaque Score; G = Gender; NoT = Number of Teeth; PC = Patient Compliance; PPD_L = Periodontal Probing Depth ≤ 3 mm; PPD_I = Periodontal Probing Depth 3 - 5 mm; PPD_H = Periodontal Probing Depth ≥ 5 mm; TD = Tissue Description.

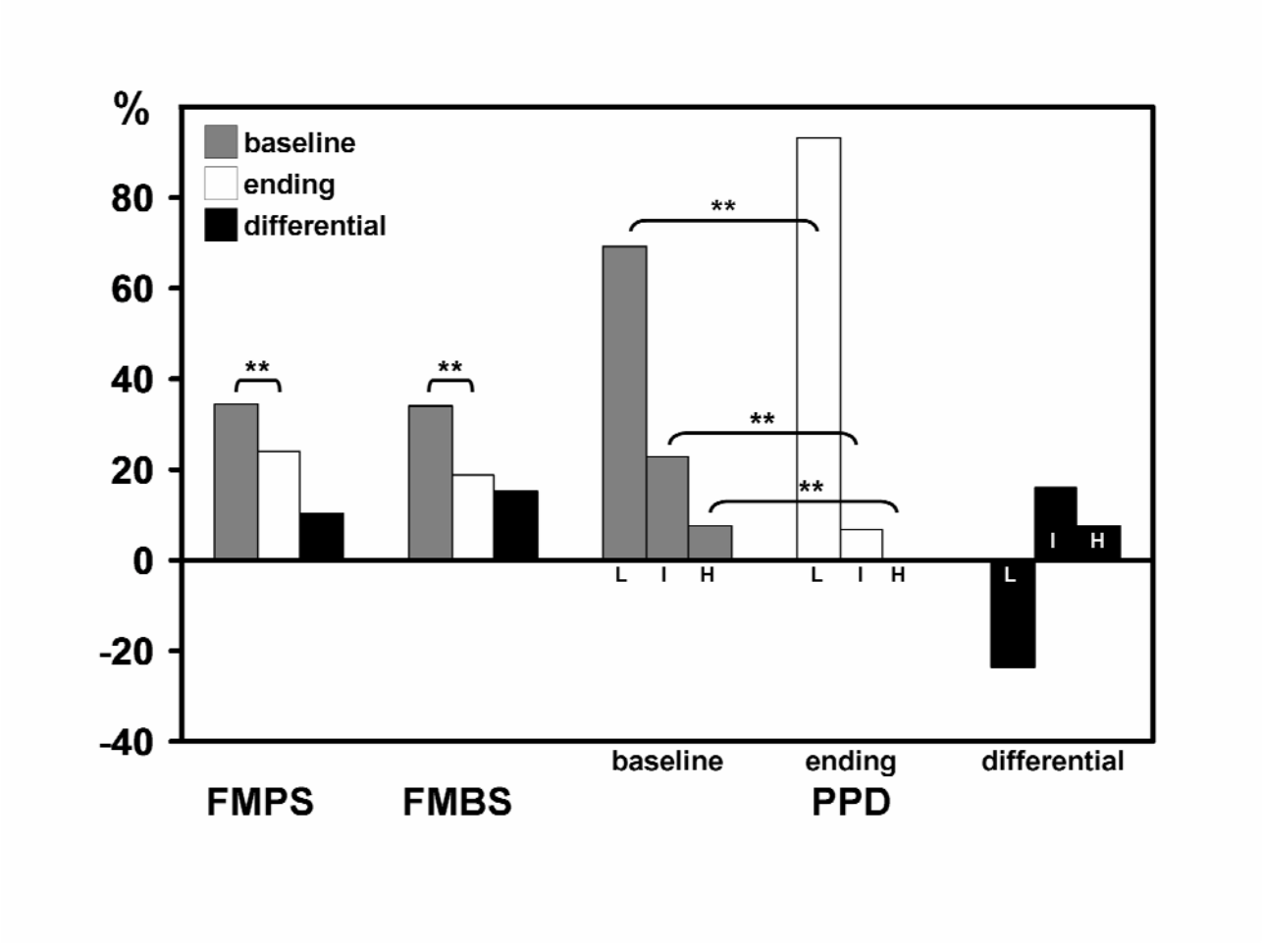

Figure 1

The average value of dental indices (N = 40), full-mouth plaque score (FMPS), full-mouth bleeding score (FMBS) and pocket probing depth (PPD), taken at baseline, ending and as differential, is reported. PPD values were categorized into three levels: L = ≤ 3 mm; I = > 3 mm and < 5 mm; H = ≥ 5 mm). The ending clinical improvement was always significant. ** = P < 0.01, after Wilcoxon rank-sum test.

Eighteen months examination

In the evaluation of quality indices - BSI: 28 patients were in levels A or B, 12 patients were in level C; TD: 6 patients were in level A, 26 patients were in level B, and 8 patients were in level C; PC: 24 patients were in level A, and 16 patients were in level B; CC: 21 patients were in level A, and 19 patients were in level B.

As shown in Figure 1 and Table 2, as compared with baseline values (FMPS = 34.3%, FMBS = 34.1%, PPD_H = 7.7%, PPD_I = 22.9%, and PPD_L = 69.4%), excluding PPD_L, all the periodontal indices recorded at the end of the study were decreased

Table 3 – Average, Standard deviation (N = 40) and Spearman correlation of dental beliefs and psychological assessments versus all clinical indices.

		HV	AI1	AI2	AII A	AII B	AII C	AS	DS
m		43.1	63.0	8.8	0.30	0.38	0.25	32.3	31.5
SD		6.4	10.1	5.2	0.46	0.49	0.44	10.6	10.2
AI1		0.5							
AI2									
AII A									
AII B									
AII C									
AS				- 0.3		0.4	0.4		
DS								0.8	
PC		0.3							
CC		0.5	0.4	0.4					
FMPS	b					0.4			
	e								
	d								
FMBS	b								
	e								
	d						0.3		
PPD_L	b	0.3					0.3		
	e								
	d	0.3					0.3		
PPD_I	b						- 0.4		
	e								
	d						- 0.4		
PPD_H	b	- 0.4				0.3			
	e								
	d	- 0.4							

Dental beliefs: AI1 = Adherence-intent scale 1; AI2 = Adherence-intent scale 2; HV = Health-value scale.

Psychological assessments: AII-A = Axis II cluster-A; AII-B = Axis II cluster-B; AII-C = Axis II cluster-C; AS = Self-rating anxiety scale; DS = Self-rating depression scale

Dental indices: FMBS = Full-mouth bleeding score; FMPS = full-mouth plaque score; PPD_L = Periodontal probing depth ≤ 3 mm; PPD_I = Periodontal probing depth 3 - 5 mm; PPD_H = Periodontal probing depth ≥ 5 mm; b = baseline; e = ending; d = differential (b - e).

(FMPS = 23.9%, FMBS = 18.8%, PPD_H = 0.1%, PPD_I = 6.8%, and PPD_L = 93.1%), thus attesting the clinical improvement. The percentage of PPD_L (pockets ≤ 3 mm) increased as a result of the periodontal treatment, thus showing a negative differential; the differences between baseline and the end of the study had always been statistically significant, as presented in figure 1.

Statistical correlations

The average, the standard deviation and the direct or inverse Spearman correlation of dental and systemic indices are reported in table 2.

Table 3 reports the Spearman correlations of psychological assessment and all clinical indices, as well as the correlation of differentials. The greatest number of correlation was recorded for PPD. The resulting correlations were:

HV was directly correlated with AI1, PC, CC, and basal PPD_L and was inversely correlated with basal PPD_H;

AI1 was directly correlated with CC;

AI2 was directly correlated with CC, and was inversely correlated with AS;

AII B (Axis II cluster B) was directly correlated with AS, basal FMPS, and PPD_H;

AII C (Axis II cluster C) was directly correlated with AS and basal PPD_L and was inversely correlated with basal PPD_I;

AS was directly correlated with DS;

Table 4 reports the coefficient and the direction of the relationship, which is the sign of the estimated coefficients after the multivariate regression model. The greatest number of clinical index correlations was recorded for AII C. The resulting correlations were:

basal FMPS was directly correlated with AII B;

Table 4 - Coefficients of statistically significant parameters ($P < 0.05$) from the stepwise multiple regression model reported at baseline, ending, and as differential value.

Baseline			Ending			Differential		
Dep-V.	Ind-V.		Dep-V.	Ind-V.		Dep-V.	Ind-V.	
FMPS	TD	- 10.7	FMPS	G	- 7.7	FMPS	TD	- 7.7
	PC	- 6.5		TD	- 6.7		HV	- 1.2
	NoT	- 1.4		PC	- 7.2		AII B	6.3
	AII B	10.2		NoT	- 0.9			
				FMBS	0.6			
				AII A	8.8			
				AII B	5.5			
				AS	- 0.3			
FMBS	BSI	- 6.6	FMBS	G	4.6	FMBS	TD	14.3
	TD	15.5		BSI	- 4.6		CC	5.2
				FMPS	0.2		AII C	6.7
				PPD_H	- 21.5		DS	- 0.3
				AII C	- 7.6			
				DS	0.2			
PPD_L	PPD_I	- 1.0	PPD_L	TD	3.4	PPD_L	TD	- 5.6
	PPD_H	- 1.0		PC	1.1		PC	- 1.9
				PPD_H	- 7.8		PPD_I	- 0.9
				AII C	- 1.8		PPD_H	- 0.8
							HV	0.1
							AI2	- 0.2
							AII C	1.9
PPD_I	PPD_L	- 1.0	PPD_I	TD	- 3.4	PPD_I	TD	5.3
	PPD_H	- 1.0		PC	- 1.3		PC	1.9
				PPD_H	6.8		PPD_L	- 0.9
				AII C	1.8		PPD_H	- 1.1
							AI2	0.2
							AII C	- 1.9
PPD_H	PPD_L	- 1.0	PPD_H	BSI	- 0.1	PPD_H	TD	0.2
	PPD_I	- 1.0		AII C	- 0.1		PPD_L	- 1.0
							PPD_I	- 1.0

A linear relationship exists between each independent variable (Ind-V.) and increase/decrease (-) of the involved dependent variable (Dep-V.).

For instance: at baseline, the FMPS considerably decreases (- 6.5 units) if the PC (Patient Compliance) increases of 1 unit (one category improvement, as from SSO category C to B), while the FMPS greatly increases (10.2 units) if the AII B (Cluster B belonging) increases of 1 unit.

AI1 = Adherence-intent scale 1; AI2 = Adherence-intent scale 2; AII A = Axis II cluster-A; AII B = Axis II cluster-B; AII C = Axis II cluster-C; BSI = Biological and structural integrity; FMBS = Full-mouth bleeding score; FMPS = Full-mouth plaque score; G = Gender; HV = Health-value scale; NoT = Number of teeth; PC = Patient compliance;

PPD_L = Periodontal probing depth ≤ 3 mm; PPD_I = Periodontal probing depth 3 - 5 mm; PPD_H = Periodontal probing depth ≥ 5 mm; AS = Self-rating anxiety scale; DS = Self-rating depression scale; TD = tissue description.

ending FMPS was directly correlated with AII A and AII B, and was inversely correlated with AS;

ending FMBS was directly correlated with DS, and was inversely correlated with AII C;

ending PPD_L was inversely correlated with AII C;

ending PPD_I was directly correlated with AII C;

and ending PPD_H was inversely correlated with AII C.

The dental and differential correlations are reported in table 4.

Finally, the psychological traits, in relation to dental belief and the other indices, are shown in Tables 3 and 4, wherein:

AII A (Cluster A) demonstrated a consistent increase in ending FMPS;

AII B (Cluster B) showed increases in AS, basal, ending, and differential FMPS, and in basal PPD_H;

AII C (Cluster C) demonstrated an increase in AS, basal PPD_L, ending PPD_I, and differential FMBS and PPD_L and it presented a decrease in ending FMBS, PPD_L, PPD_H, and basal and differential PPD_I.

Discussion

Our study was designed to evaluate the relationship between psychological traits, moderate periodontal diseases, dental health, and oral hygiene behavior of the patients with reference to periodontal clinical outcomes. To date, the relationship between periodontal diseases and peculiar psychosocial predisposing factors is established only for some diseases, such as acute necrotizing ulcerative gingivitis, and is reportedly

associated with anxiety, depression, and other emotional disturbances [7, 36].

In our present study, patients affected by advanced periodontitis were excluded. This decision lies in the attempt to reduce the impact of major confounding variables by taking into account the complexity of severe periodontitis that entails elaborate and different therapeutic strategies [27, 37].

To define personality traits, we used the SCID-II interview as it consists of a series of open-ended questions designed to diagnose personality traits and disorders, in which the latter is the exclusion criteria, and to identify the basic features of a personality. The transition to disorder diagnosis requires the presence of a number of criteria and the overcoming of some reference cutting scores [31]. The structured interview allowed a much more accurate assessment of personality traits than the simple self-administered questionnaires.

Only a few studies analyzed personality traits. These studies also considered periodontal outcomes in patients under periodontal maintenance [19] and evaluated personality differences by comparing patients who had periodontal and maintenance therapies with those patients who only had periodontal therapy and no maintenance therapy [18]. However, patient compliance is always the main variable analyzed in reference to personality. The isolated influence of personality traits that are often associated with the behavioral mechanism of noncompliance to periodontal maintenance therapy in patients who underwent a complete periodontal treatment had not been clearly investigated in the literatures [20]. Personality traits are more stable over time, whereas affective states are less persistent. To avoid changes in affective recording collected during the short second step, we needed to assess psychological information just before the periodontal treatment, and its significance was observed during the third and the fourth steps.

The use of PPD in our study as the main clinical parameter to measure the modifications in periodontal tissues aimed to reduce the impact of biases derived from the use of multiple measurements [8].

A relevant part of the therapeutic approach consisted of the enforcement of an oral health education program and the performance of causal and supportive therapies including additional periodontal therapy, if needed, and patients suffering from severe periodontitis were excluded from our study [25, 27]. The nonsurgical therapy has the greatest efficacy in the treatment of shallow periodontal pockets, or the lesions most observed in this study [38].

It can be considered that educational interventions are sufficient to change a patient's behavior [11, 39], and that patients who persevere in their behavior are psychologically dissimilar from compliers in a certain degree [12,40]. Moreover, the successful long-term periodontal therapy requires exceptional patient compliance to periodontal therapy and maintenance program. The maintenance program is necessary to retain treatment benefits and to prevent relapse of the disease [20,41]. Time constraints, prolonged treatment plans, and the perceived unimportance of periodontal maintenance therapy, have been noted as the factors that contribute to poor patient compliance [20]. Noncompliance to periodontal maintenance cannot be explained by one determinant only, rather it may involve numerous aspects such as individual's health beliefs, emotional aptitude, psychological stressors, and personality traits. The personality traits are generally stable; however, factors affecting how these traits impact periodontal outcomes remain to be carefully explored [19, 20]. Thus, to avoid confounding variables that could induce significant compliance changes, only patients showing a higher degree level of compliance were included in the study [18-20].

In our study, the treatment approach consistently resulted in an increase in sites with

PPD_L and in a simultaneous decrease in PPD_I and PPD_H. We decided to report only the less expected outcomes and only those that are pertaining to the objectives of our study. Moreover, all the periodontal indices measured at baseline showed a significant clinical improvement at the end of the follow-up, as an expected outcome of successful therapy. Many correlations, such as a direct relationship of periodontal indices between baseline and ending indices, were expected. Therefore, beyond the clinical improvement with periodontal therapy, the better the baseline periodontal indices, the better the outcome is 18 months later. PC showed a positive correlation with periodontal indices [19,20]. In this study, baseline and ending indices were always positively correlated. There is a reasonable conjecture that patients demonstrate a broader compliance range prior to the study. This is a patient's unavoidable-aspect that has to be kept into consideration.

Generally, cluster A, B, and C personality traits interfered with periodontal indices in a complex manner. Cluster A showed a greater leverage to lead to an increase in FMPS-e. Cluster B was effective in increasing FMPS-b, FMPS-d, FMPS-e, and PPD_H-b. On the contrary, cluster C traits, including avoidant, dependent, and obsessive-compulsive personality traits, seemed to be linked to an effective decrease in FMBS-e, improvements in FMBS-d, and a feeble decrease in PPD_H-e. Conversely, cluster C was associated with a greater PPD_I-e and a lesser PPD_L-e. The feeble increase in intermediate pockets, which was approximately 2%, together with the similar decrease in PPD_L, is clinically unfavorable and opposite to the effective FMBS outcome of cluster C. However, no relationship between clusters and compliance was found; however, the study was planned to control the leverage of this variable.

The data and correlations observed at baseline were probably also related to the oral hygiene behavior of patients prior to the study, whereas the differential and ending data greatly affected patients that are subjected to the study protocol for 18 months.

Only few data available in the literature isolated personality factors from behavioral mechanisms of noncompliance [20]. Becker et al. [18] did not find significant personality differences between the compliers and noncompliers undergoing supportive periodontal therapy. However, compliant patients exhibited more favorable trend of clinical outcomes than noncompliers. The noncompliant group showed a higher frequency of stressful life events, whereas compliers demonstrated a more positive self-image. The noncompliant group also showed less stability in personal relationships, defensiveness toward periodontal therapy, and a ‘‘child-like’’ orientation. Neuroticism and conscientiousness are most widely associated with noncompliance [20]. Neuroticism is often expressed through anxiety, anger, hostility, impulsiveness, or depression and is frequently related to somatic distress. Depression, in particular, has been identified as a risk factor for medical noncompliance [19,20].

In this study, patients with personality disorders were excluded. The presence of paranoid, schizoid, and schizotypal personality (cluster A) or borderline, antisocial, histrionic, and narcissistic personality traits (cluster B) are not suitable to obtain favorable clinical results in the periodontal therapy of mild periodontitis. These traits could be so powerful to influence patients beyond their knowledge. Multivariate data processing showed that cluster C personality traits are associated with favorable therapeutic outcomes. Patients with obsessive traits (80%) prevail within cluster C, thus indicating the propensity to accuracy and perfectionism of this group, albeit a correlation between cluster C and PC, AI1 and 2 scales and/or HV scale was not found. It is also possible that these powerful psychosocial factors are associated with immune-hindering and infectious diseases and vice versa [7].

The Spearman test showed a positive correlation between cluster B and C and AS, and between AS and DS. The AS seemed to induce a favorable clinical effect on FMPS-e.

Moreover, the different components of DBQ were correlated with each other, showing a clinical improvement in dental indices. AI2, in particular, resulted in an inverse correlation with AS; and it was also inversely correlated with HV, however, the correlation was not significant. DS seemed to be related to an increase in FMBS-e and a decrease in FMBS-d, thus showing an opposite clinical role as compared to that of the cluster C, which is in line with the findings of other studies [16, 42].

Presumably, the affective states anxiety and depression combine and stress the personality traits [18,19,20]. However, it was reported that both anxiety and depression have a strong leverage in negatively influencing the patient compliance, which was controlled in this study [19,20]. Personality traits seemed to play significant favorable or unfavorable roles in determining therapeutic outcomes of periodontal therapy.

Most published studies support a positive association between periodontitis and several psychosocial factors, mainly socioeconomic status, anxiety, depression, lack of social support, and stress; however, no such positive association were made with personality traits isolated from compliance. In this study, compliance was not only evaluated as program attendance [28], rather it was evaluated in a more complete manner [21,22]. This study aimed to evaluate the influence of personality traits on periodontal therapy by limiting the compliance variation as much as possible and by also considering the affective states and not excluding other pathodynamic ways [7]. Hence, it seemed realistic that several important psychological, affective, or behavioral factors could have an important leverage in a patient's personality to influence the periodontal therapy outcomes. We believe that personality traits have to be diagnosed and considered in relation to periodontal therapy as personality traits seem to have a direct influence on periodontal indices and a synergy with other psychological factors beyond the influence of patient compliance during the study.

The advancements in knowledge of the patient psychological traits could be of great importance in targeting the therapeutic goals and the possible “crucial points” of treatment strategies to improve the treatment outcomes.

Acknowledgments

We thank DDS, MDent Andrea Lucchi, DDS, MDent Chiara Pellacani (Private Dental practice), and Mrs. Domenica Bussi for the technical and organizing assistance during the study.

This study was funded by the authors' own institution.

The authors declare that they have no conflicts of interests.

References

01 Highfield J. Diagnosis and classification of periodontal disease. Aust Dent J. 2009 Sep;54 Suppl 1:S11-26.

02 Kinane DF, Bartold PM. Clinical relevance of the host responses of periodontitis. Periodontol 2000 2007; 43:278-293.

03 Hernández M, Dutzan N, García-Sesnich J, Abusleme L, Dezerega A, Silva N, González FE, Vernal R, Sorsa T, Gamonal J. Host-pathogen interactions in progressive chronic periodontitis. J Dent Res. 2011 Oct;90(10):1164-70.

04 Bertoldi C, Bellei E, Pellacani C, et al. Non-bacterial protein expression in periodontal pockets by proteome analysis. J Clin Periodontol 2013; 40:573-582.

05 Genco RJ, Borgnakke WS. Risk factors for periodontal disease. Periodontol 2000. 2013 Jun;62(1):59-94.

06 Monteiro da Silva AM, Oakley DA, Newman HN, Nohl FS, Lloyd HM. Psychosocial factors and adult onset rapidly progressive periodontitis. J Clin Periodontol 1996; 23:789–794.

07 Vettore MV, Leão AT, Monteiro Da Silva AM, Quintanilha RS, Lamarca GA. The relationship of stress and anxiety with chronic periodontitis. J Clin Periodontol 2003; 30:394-402.

08 Peruzzo DC, Benatti BB, Ambrosano GM, et al. A systematic review of stress and psychological factors as possible risk factors for periodontal disease. J Periodontol 2007; 78:1491-1504.

09 Solis AC, Lotufo RF, Pannuti CM, Brunheiro EC, Marques AH, Lotufo-Neto F. Association of periodontal disease to anxiety and depression symptoms, and psychosocial stress factors. J Clin Periodontol 2004; 31:633-638.

10 Renz A, Ide M, Newton T, Robinson PG, Smith D. Psychological interventions to improve adherence to oral hygiene instructions in adults with periodontal diseases. Cochrane Database Syst Rev 2007; 2:CD005097.

11 Jönsson B, Öhrn K, Oscarson N, Lindberg P. The effectiveness of an individually tailored oral health educational programme on oral hygiene behaviour in patients with periodontal disease: a blinded randomized-controlled clinical trial one-year follow-up;. J Clin Periodontol 2009; 36:1025–1034.

12 Newton JT. Psychological models of behaviour change and oral hygiene behaviour in individuals with periodontitis: a call for more and better trials of interventions. J Clin Periodontol 2010; 37:910–911.

13 Newton JT. Asimakopoulou K. Managing oral hygiene as a risk factor for periodontal disease: a systematic review of psychological approaches to behaviour change for improved plaque control in periodontal management. J Clin Periodontol 2015; 42 (Suppl. 16): S36–S46.

14 Perez A, Amin M. Dimensional Analysis of Psychosocial Barriers to Prevention of Early Childhood Caries Among Recent Immigrants. SAGE Open 2014; 4:1-9.

15 Saletu A, Pirker-Frûhauf 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.

16~~9~~ Borkowska ED, Watts TLP, Weinman J. The relationship of health beliefs and psychological mood to patient adherence to oral hygiene behaviour. J Clin Periodontol 1998; 25:187-193.

17 Axtelius B, Söderfeldt B, Nilsson A, Edwardsson S, Attström R. Therapy-resistant periodontitis. Psychosocial characteristics. J Clin Periodontol 1998 Jun;25(6):482-91.

18 Becker BE, Karp CL, Becker W, Berg L. Personality differences and stressful life

events. Differences between treated periodontal patients with and without maintenance. J Clin Periodontol 1988; 15:49-52.

19 Costa FO, Miranda Cota LO, Pereira Lages EJ, Vilela Câmara GC, Cortelli SC, Cortelli JR, Costa JE, Medeiros Lorentz TC. Oral impact on daily performance, personality traits, and compliance in periodontal maintenance therapy. J Periodontol 2011; 82:1146-1154.

20 Umaki TM, Umaki MR, Cobb CM. The psychology of patient compliance: a focused review of the literature. J Periodontol. 2012; 83: 395-400.

21 Eickholz P, Kaltschmitt J, Berbig J, Reitmeir P, Pretzl B. Tooth loss after active periodontal therapy. 1:patient-related factors for risk:prognosis:and quality of outcome. J Clin Periodontol 2008; 35:165-174.

22 SSO Schweizerische Zahnärztegesellschaft SSO, Qualitätsleitlinien in der Zahnmedizin. SSO, Bern, 2000]

23 Rotundo R, Pini Prato GP A new computerised method for evaluating risk profiles of periodontal patients. Periodontal Practice Today 2007; 4: 139-149,.

2 Puri KS, Suresh KR, Gogtay NJ, Thatte UM. Declaration of Helsinki 2008: implications for stakeholders in research. J Postgrad Med 2009; 55:131-134.

25 SIdP guidelines. http://www.sidp.it/la-societa/linee-guida-sidp/ Accessed on 11 January 2013

26 American Psychiatric Association 2000. Diagnostic and statistical manual of mental disorders - Text revision. 4th edition. Arlington VA: APA; 2000. p. 943.

27 Page RC, Eke PI. Case definitions for use in population-based surveillance of periodontitis. J Periodontol 2007; 78 (Suppl 7):1387-1399.

28 Checchi L, Pelliccioni GA, Gatto MR, Kelescian L. Patient compliance with maintenance therapy in an Italian periodontal practice. J Clin Periodontol 1994;

21:309-312

29 Bertoldi C, Lalla M, Pradelli J.M, Cortellini P, Lucchi A, Zaffe D. Risk factors and socioeconomic condition effects on periodontal and dental health: a pilot study among over 50. Eur J Dent 2013; 7:336-346.

30 Schuman H, Presser S. Questions and answers in attitude surveys: experiments on question form wording and context. Thousand Oaks, CA: SAGE Publications; 1996. p. 371.

31 F Mazzi, P Morosini, G De Girolamo, GP Guaraldi L'assessment dei disturbi della personalità dell'Asse II del DSM-IV [Italian translation of SCID-II structured clinical interview for DSM-IV Axis II disorders by First MB, Gibbon M, Spitzer RL, Williams JBW, Benjamin LS.], Firenze (I): Giunti Organizzazioni Speciali; 2003.

32 Zung WWK. The depression status inventory: an adjunct to the Self-Rating Depression Scale. J Clin Psychol 1972; 28:539–543.

33 Zung WWK. The measurement of affects, depression and anxiety. Mod Probl Pharmacopsychiatry 1974; 7:170-188.

34 Associazione per la ricerca in psicoterapia cognitivo interpersonale. Test di autovalutazione dell'ansia di Zung - Test di autovalutazione della depressione di Zung. http://www.arpci.it/autotest.htm/ Accessed on 11 January, 2013.

35 Stata statistical software. Release 9. College Station TX: StataCorp LP; vol. 1-4. 2005.

36 Goldhaber P, Giddon DB. Present concepts concerning the etiology and treatment of acute necrotizing ulcerative gingivitis. Int Dent J 1964; 14:468-496.

37 Cortellini P, Tonetti MS.. Clinical and radiographic outcomes of the modified minimally invasive surgical technique with and without regenerative materials: a randomized-controlled trial in intra-bony defects. J Clin Periodontol 2011; 38:365-

373.

38 Heitz-Mayfield LJ, Trombelli L, Heitz F, Needleman I, Moles D. A systematic review of the effect of surgical debridement vs non-surgical debridement for the treatment of chronic periodontitis. J Clin Periodontol 2002; 29:92-102.

39 Hugoson A, Lundgren D, Asklöw B, Borgklint G. Effect of three different dental health preventive programmes on young adult individuals: a randomized, blinded, parallel group, controlled evaluation of oral hygiene behaviour on plaque and gingivitis. J Clin Periodontol. 2007; 34:407-415.

40 Lorentz TC, Cota LO, Cortelli JR, Vargas AM, Costa FO. Prospective study of complier individuals under periodontal maintenance therapy: analysis of clinical periodontal parameters: risk predictors and the progression of periodontitis. J Clin Periodontol 2009; 36:58–67.

41 Tonetti MS, Steffen P, Muller-Campanile V, Suvan J, Lang NP. Initial extractions and tooth loss during supportive care in a periodontal population seeking comprehensive care. J Clin Periodontol 2000; 27:824-831.

42 DiMatteo MR, Lepper HS, Croghan TW. Depression is a risk factor for noncompliance with medical treatment: Meta-analysis of the effects of anxiety and depression on patient adherence. Arch Intern Med 2000;160: 2101-2107.