Società Italiana
di Parodontologia

Comparison between two methods for periodontal risk assessment

Confronto tra 2 metodi per la valutazione del rischio parodontale

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ATTI DELLA SESSIONE DI RICERCA - PREMIO "HENRY M. GOLDMAN" 2009 / *PROCEEDINGS BOOK RESEARCH SESSION – "HENRY M. GOLDMAN" PRIZE 2009*

Summary

Risk assessment is increasingly important in Periodontology. We proposed a new objective method (UniFe) in order to simplify the risk assessment procedures and compared it with a computer-based risk assessment tool (PAT®). The comparison between UniFe and PAT® demonstrated a good level of agreement between methods in randomly selected population referred to a periodontal clinic.

Riassunto

La valutazione del rischio sta assumendo una rilevanza crescente in Parodontologia. Recentemente abbiamo proposto un nuovo metodo obiettivo (*UniFe*) al fine di semplificare le procedure di valutazione del rischio. Il confronto di *UniFe* con una algoritmo informatizzato di calcolo del rischio (*PAT®*), condotto su un campione di pazienti afferenti ad un centro specializzato nel trattamento delle malattie parodontali, ha dimostrato un buon livello di accordo tra i due metodi.

Introduction

Susceptibility to periodontal disease is extremely variable among subjects in terms of both incidence and progression of the disease[1,2] and subject response to treatment. The nature of this variability can be found only in part (50%) in genetic heredity, the remaining susceptibility being sustained by other risk determinants which have been identified by longitudinal studies.

Risk assessment has been defined as the process by which qualitative or quantitative assessments are made of the likelihood for adverse events to occur as a result of exposure to specified health hazards or by the absence of beneficial influences[3]. The evaluation of risk determinants in Periodontology is fundamental for the early identification of high-risk subjects and the formulation of individualized preventive and therapeutic strategies, which aim to the targeted control of risk factors[4]. Subjective risk assessment consists of identifying risk factors an individual patient may manifest during the examination and history-taking process, and then making a subjective qualitative judgement as to the magnitude and role these factors may be playing in the disease status. However, scientific evidence suggests that the judgment generated by the subjective evaluation of expert clinicians in terms of subject-based level of risk is highly variable and could result in the misapplication of treatment for some patients. In the last years, these observations on the subjectivity of risk assessment called for the development of new and more objective methods to evaluate the periodontal risk, in order to tentatively obtain more uniform and accurate information which may optimize the clinical decision making, improve oral health for patients and reduce health care costs.

The *Oral Health Information Suite®* (*OHIS®*) is an information system that compiles, analyses and quantifies clinical information about current oral health status and risk. *OHIS®* has been developed and patented by Previser Inc., and is available on the internet. The *Periodontal Assessment Tool* (*PAT®*) is a computer-based component of the *OHIS®* specifically for periodontal disease[5]. A study was conducted in order to retrospectively evaluate the validity and accuracy of *PAT®* on a pool of 523 subjects monitored for clinical and radiographic signs of disease occurrence/progression over an observation interval of 15 years[6]. The results of the study demonstrated a high correlation between the *PAT®*-generated risk scores and changes in periodontal status (alveolar bone loss and tooth loss).

Recently, we proposed a simplified method (*UniFe*) for periodontal risk assessment based on 5 parameters which are derived from the patient medical history and clinical recordings[7-9]. The aim of the present study was to compare the *UniFe* method with *PAT®* in a randomly selected population referred to a periodontal clinic. The *UniFe* parameter/s mostly explaining the discrepancy between *UniFe*- and *PAT®*-generated risk scores were also investigated.

Materials and Methods

Study population

Data for risk assessment were retrospectively derived from the record charts of patients seeking periodontal care at the Research Centre for the Study of Periodontal Diseases, University of Ferrara. The study population was selected according to a

computer-generated randomization list. Each patient was considered eligible for study inclusion according to the following criteria:

- dentate or partially edentulous patients;
- availability of dental/medical history as well as clinical and radiographic data necessary for risk assessment according to both investigated methods;
- no systemic diseases other than diabetes mellitus which may affect the periodontal status.

Data for risk assessment were obtained by 2 investigators (R.F. and S.F.), 1 for *UniFe* and 1 for *PAT®*, who were blinded as to the aim of the study.

Periodontal Risk Assessment

UniFe

Risk assessment according to *UniFe* method is based on 5 parameters which are derived from the patient medical history and clinical recordings. *UniFe* parameters are as follows:

– *smoking status*: recorded as "non-smoker", "former smoker" or "current smoker". For current smokers, the daily consumption of cigarettes was registered;

diabetic status (both type 1 and type 2 diabetes mellitus were considered): recorded as "non-diabetic", "controlled diabetic" (i.e. serum glycosilated haemoglobin < 7.0% at the last exam), "poorly controlled diabetic" (i.e. serum glycosilated haemoglobin ≥ 7.0% at the last exam);

– *number of sites with probing depth ≥ 5 mm*: probing depth had been measured from the gingival margin to the bottom of the pocket. Probing measurements had been performed by using a manual pressure sensitive probe (CP 12; Hu-Friedy, Chicago, Illinois, US), at approximately 0.3 N force, on 6 aspects for each teeth (mesio-buccal, mid-buccal, disto-buccal, mesio-lingual, mid-lingual, disto-lingual). The number of sites with probing depth ≥ 5 mm was counted for each patient;

– *Bleeding on Probing Score (BoP)*: each probed site had been recorded as positive when bleeding was present after probe insertion. BoP was calculated as the percentage of positive sites over the total number of probed sites;

– *bone loss/age:* bone loss was recorded as the number of teeth with a distance from the cement-enamel junction to the alveolar crest ≥ 4 mm on at least one interproximal (mesial or distal) aspect, as measured on periapical radiographs. Age was expressed in years. A special chart was arbitrarily created to match the patient age with the severity of bone loss (Table 1e).

Each parameter received different scores ("parameter score"), as shown in (Tables 1a-e). The algebric sum of the parameter scores was calculated and then referred to 5 "risk scores": score 1 (low risk), 2 (low-medium risk), 3 (medium risk), 4 (medium-high risk), and 5 (high risk) (Table 2).

PAT®

For PAT risk calculation, data input was made according to the internet-based data sheet (www.previser.com). *PAT®* reports a risk score on a scale from 1 (lowest risk) to 5 (highest risk).

Statistical analysis

Statistical analysis was performed with *STATA v8.0* (StataCorp LP; Texas, USA) and *SPSS v15.0* (SPSS Inc.; Chicago, Illinois, USA). The subject was considered as the statistical unit. All the clinical measurements and risk scores were expressed as mean ± standard deviation (SD).

Cohen *k*-statistics, weighted according to quadratic structure, was calculated to evaluate the level of agreement between *UniFe* and *PAT®*.

For each subject, DIFF was calculated as the difference between *UniFe* risk score and *PAT®* risk score. A negative value of DIFF, therefore, indicates that *UniFe* risk score was lower than *PAT®* risk score, while a positive value of DIFF indicates that *UniFe* risk score was higher than *PAT®* risk score.

To explain DIFF variability, first a linear regression analysis was conducted using DIFF as dependent variable and each of the 5 *UniFe* parameter scores as predictors. Secondly, the *UniFe* parameter scores were entered into a multiple regression analysis with backward stepwise structure.

Results

107 patients (34 males and 73 females, mean age: 45.5 ± 9.9) were included in the present study. 45 patients had never smoked, 18 patients were former smokers and 44 patients were current smokers. 2 patients were affected by diabetes mellitus (1 patient by type 1 and 1 by type 2). 1 patient was a controlled diabetic, while 1 patient was a poorly controlled diabetic. Patients presented 29.2 ± 23.8 pockets with probing depth ≥ 5 mm (range: 0 - 113), a BoP of 31.9 ± 17.7 % (range: 1.8 % - 83.3 %), and 16.3 ± 7.6 teeth with radiographic bone loss ≥ 4 mm (range: 0 - 31).

The *UniFe* risk score was 4.5 ± 0.9, the *PAT®* risk score was 4.6 ± 0.7. The distribution of the study population according to the *UniFe®* and *PAT®* risk scores is illustrated in Table 3. Cohen *k*-statistics amounted to 0.70 (95% CI: 0.42-0.99), suggesting a good level of agreement between methods.

Linear regression analysis, using *UniFe* parameter scores as independent variables and DIFF as dependent variable, showed a significantly positive correlation between

DIFF and the parameter score associated with a) number of sites with probing depth ≥ 5mm, b) BoP and c) bone loss/age ($p < 0.000$) (Table 4). When a backward stepwise multiple regression analysis was performed in order to assess the contribution of each *UniFe* parameter score to DIFF variability, the model preserved the parameters BoP and bone loss/age, which were both statistically significant ($p < 0.000$). The regression model including BoP and bone loss/age was shown to be statistically significant ($F = 33.246$, $p < 0.000$; adjusted $R^2 = 0.378$).

Discussion

In the present study we proposed a simplified method (*UniFe*) for periodontal risk assessment and compared it with a previously validated, computer-based tool (*PAT®*). Risk scores for both methods were calculated for 107 patients, randomly selected among patients seeking care at a specialist periodontal clinic. The results indicate that: i) the great majority of the patients was assigned a high risk score (4 or 5) according to both methods; ii) a good level of agreement was observed between methods (weighted *k*-score = 0.70), with a complete agreement in 74.8% of patients; iii) differences in risk score between methods were significantly explained by the parameter scores BoP and bone loss/age (adjusted $R^2 = 0.378$).

Several methods have been proposed for the assessment of periodontal risk, which account for varying parameters that are related to the periodontal infection, host response, genetic traits, and disease signs. However, only *PAT®* was validated by longitudinal studies based on cohorts of untreated periodontal patients. *PAT®* - generated risk scores were proven to be strong predictors of alveolar bone loss and tooth loss over a 15-year period[6,10]. Unfortunately, *PAT®* is based on several parameters including patient age, frequency of dental visits, smoking history, diabetes status, oral hygiene status, history of pocket-reducing periodontal surgery, pocket depth (deepest pocket in each sextant), bleeding on probing, restorations below the gingival margin, root calculus below the gingival margin, radiographic bone height, furcation involvement, and vertical bone lesions. Moreover, the algorithm for risk calculation with *PAT®* is presently not published. Therefore, we decided to evaluate a simplified method for risk assessment and comparing it with *PAT®* for external validation.

UniFe method was based on parameters which are easily derived from the patient medical history and clinical recordings, i.e. smoking status, diabetic status, number of sites with probing depth ≥ 5 mm, BoP, and bone loss/age. Smoking and diabetes mellitus are considered as two major risk factors for periodontitis[4], due to their strong association with the incidence and progression of the disease. The severity of the periodontal tissue destruction was demonstrated to be correlated with daily cigarette consumption as well as diabetic status and poor glycaemic control. The

presence of deep residual pockets has been associated with disease progression on a site- and patient-specific basis. While the positive predictive value for disease progression of BoP at a site level is relatively low, there is evidence that individuals are at lower risk for disease progression if the prevalence of BoP at a subject level is less than 20%. Retrospective studies have shown that the amount of alveolar bone loss or the number of teeth present at baseline, which represents the patient history of periodontitis, may be used to predict further progression of untreated periodontitis. Although the derived parameter bone loss/age was included in previously proposed methods for risk assessment, no longitudinal studies that evaluated its predictive value are currently available.

UniFe and *PAT®* scores showed a complete agreement (i.e. DIFF= 0) in 74.8% of patients with a *k*-score of 0.70. The agreement within methods tended to increase from the lowest to the highest risk scores (Table 3). In our material, data were derived from patients who were randomly selected among those seeking care in a periodontal clinic. This may have resulted in a selection bias, which may partly account for the inclusion of a cohort unbalanced towards the highest parameter scores and risk scores (Table 3). Therefore, the level of agreement between *UniFe* and *PAT®* observed in the present study population could have been affected by the uneven distribution of the subjects according to their risk score. However, it should be noted that a significantly positive correlation between DIFF and the parameter score associated with number of sites with probing depth ≥ 5mm, BoP and bone loss/age was observed (Table 4). In other words, the level of agreement between *UniFe* and *PAT®* scores tends to increase when less pockets, gingival inflammation and bone loss with respect to patient age are present.

In our method, each of the 5 parameters was categorized, and each category received a different score ("parameter score") ranging from 0 to 8. *UniFe* risk score results from the algebraic sum of the single parameter scores. Therefore, our method suffered from three major limitations: 1) the number of parameters included in risk computation was limited, 2) the relative predictive value of each parameter score in contributing the overall risk score was arbitrarily assigned, and 3) the summative or negative interaction between the considered risk factors/indicators was not accounted for in risk calculation. Unfortunately, longitudinal studies based on large cohorts on major risk factors/indicators associated with the onset/progression of periodontitis which clearly define the relative risk of each of the considered parameters when present alone or in combination are still lacking. Therefore, these limitations are shared by most, if not all, the methods that have been proposed for risk assessment.

The present method for periodontal risk assessment is based on the assumption that the risk factors/indicators that may affect the onset of periodontal disease are

the same that are involved in the progression of the disease status. For some of the considered parameters, such as smoking, bleeding upon probing and diabetes, the role in the onset and progression of periodontitis have been established. In contrast, the parameters related to signs of periodontal destruction, such as pockets and bone defects, may only have some value to predict the progression of the disease.

In conclusion, we reported on a new simplified method for assessing the risk level for periodontitis. The comparison between this methods and *PAT®* demonstrated a good level of agreement between methods in randomly selected population referred to a periodontal clinic. *UniFe* method needs to be validated in longitudinal studies where untreated patients with different periodontal status are long-term evaluated.

Acknowledgements

The present study was supported by the Research Centre for the Study of Periodontal Diseases, University of Ferrara, Italy and by GABA International, Münchenstein, Switzerland. The Authors wish to thank Paola Lupi, R.D.H. and Donatella Gamberoni, R.D.H. for their help in data collection.

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Table 1a. UniFe method: generation of the score related to smoking status

smoking status	parameter score
never smoked	0
former smoker	1
1-9 cigarettes per day	2
10-19 cigarettes per day	3
≥20 cigarettes per day	4

Table 1b. UniFe method: generation of the score related to diabetic status

diabetic status	parameter score
non diabetic	0
controlled diabetic (sieric HbA1c < 7,0%)	2
poorly controlled diabetic (sieric HbA1c ≥ 7,0%)	4

Table 1c. UniFe method: generation of the score related to the number of pockets with probing depth ≥ 5mm

number of pockets with probing depth ≥ 5mm	parameter score
0-1	0
2-4	1
5-7	2
8-10	3
>10	4

Table 1d. UniFe method: generation of the score related to the Bleeding on Probing Score

Bleeding on Probing Score (%)	parameter score
0-5%	0
6-16%	1
17-24%	2
25-36%	3
>36%	4

Table 1e. UniFe method: generation of the score related to the bone loss/age

			bone loss (number of teeth with radiographic bone loss ≥4 mm)			
		0	1-3	4-6	7-10	>10
age (years)	0-25	0	8	8	8	8
	26-40	0	6	6	8	8
	41-50	0	4	4	6	8
	51-65	0	2	4	6	8
	>65	0	0	2	4	6

Table 2. UniFe method: determination of the risk score. The parameter scores obtained from Tables 1a-e are added and the sum (in parenthesis) is referred to a risk score ranging from 1 to 5.

risk score: 1 LOW risk	risk score: 2 LOW-MEDIUM risk	risk score: 3 MEDIUM risk	risk score: 4 MEDIUM-HIGH risk	risk score: 5 HIGH risk
(0 - 2)	(3 - 5)	(6 - 8)	(9 - 14)	(15 - 24)

Table 3. Distribution of the study population according to the UniFe® and PAT® risk scores. In bold: agreement between UniFe® and PAT®

		PAT© risk score					
		1	2	3	4	5	Total
UniFe© risk score	1	**0**	1	3	0	0	4
	2	0	**0**	1	1	0	2
	3	0	0	**2**	0	0	2
	4	0	1	0	**17**	8	26
	5	0	0	0	12	**61**	73
	Total	0	2	6	30	69	107

Table 4. Linear regression analysis conducted between the UniFe parameters (independent variables: smoking status, number of sites with probing depth ≥ 5 mm, Bleeding on Probing Score, bone loss/age) and DIFF (dependent variable)

	coefficient	standard error	t	P>ltl	95% confidence interval	
Smoking status	0.0114305	0.0403626	0.28	0.778	- 0.0686011	0.0914622
N° of Sites With Probing Depth ≥ 5mm	0.1834655	0.0432992	4.24	0.000	0.0976111	0.2693198
Bleeding on Probing Score	0.219116	0.0435771	5.03	0.000	0.1327106	0.3055214
Bone loss/Age	0.1684566	0.0255571	6.59	0.000	0.1177816	0.2191316

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