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## A new computerised method for evaluating risk profiles of periodontal patients



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As the first step in the treatment approach to the individual patient, practitioners should collect all the anamnestic and clinical data in order to make a correct diagnosis, establish a prognosis and create an appropriate treatment plan. This entire process should be based on evidence-based criteria. The aim of this paper is to propose a new computerised method of recording and assessing clinical data that can facilitate the prognostic evaluation and increase the degree of patient compliance.

### ■ Introduction

It is a well-known fact that data collection (anamnestic and clinical) is of strategic value in formulating a correct diagnosis, deciding appropriate treatment and assessing a prognosis. This should be based on information from the scientific literature (evidence-based medicine). Since periodontitis is a multifactorial disease<sup>1-4</sup>, several factors influence the onset and progression of the disease. Risk factors are defined as 'environmental, behavioural or biological factors confirmed by temporal sequence, usually in longitudinal studies, which, if present, directly increase the probability of a disease occurring, and if absent or removed, reduce that probability. Risk factors are part of the causal chain, or expose the host to the causal chain.' Prognostic factors are defined as 'environmental, behavioural or biological factors which,

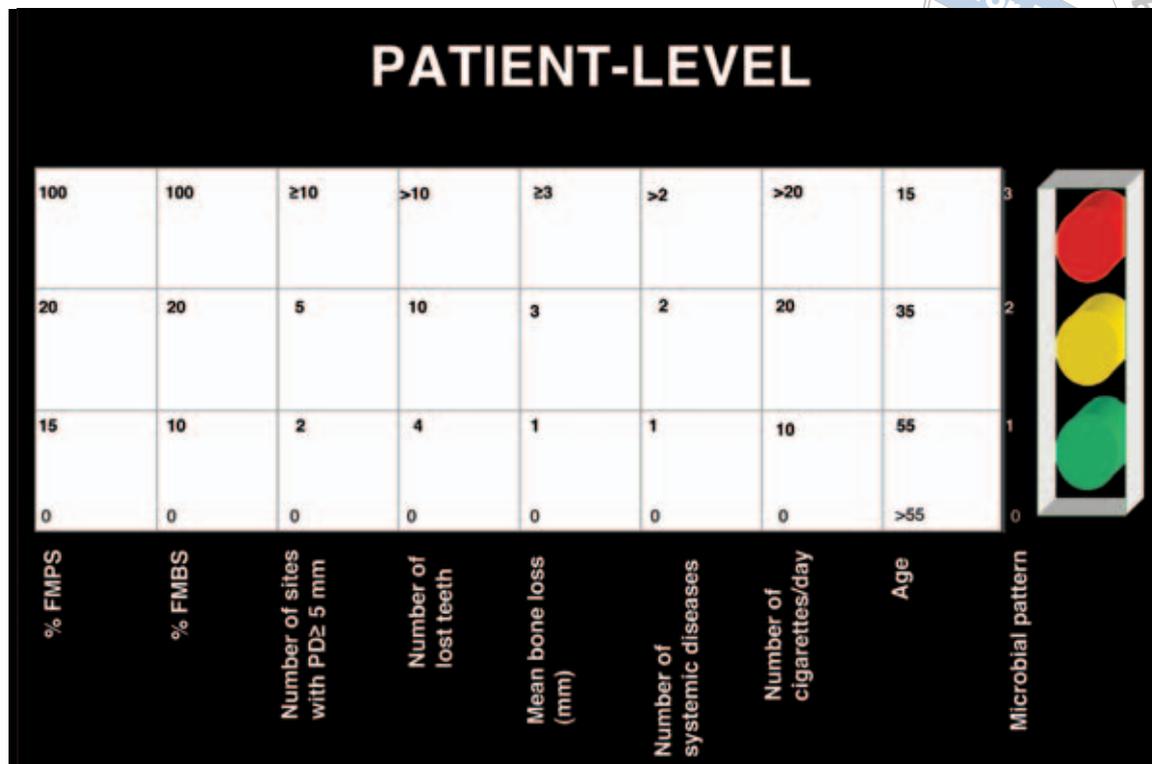
when present, directly affect the probability of a positive outcome of therapy rendered for the disease'<sup>5</sup>. In some instances, factors may act as risk and prognostic factors (e.g. smoking).

Therefore, in their daily clinical practice, it is essential that professionals identify, evaluate and manage the risk and prognostic factors to establish a proper treatment plan.

In order to facilitate the identification and classification of these factors, some authors suggested a method of assessment based on a three-level approach, at patient-, tooth- and site-level<sup>6</sup>.

Much clinical data should be recorded and several programs are available to manage all of these data.

The aim of this paper is to present a computerised method of recording and assessing clinical periodontal-related data in order to provide a risk-profile at patient-, tooth- and site-level and, consequently, to



**Fig 1** Patient-related records. FMPS, full mouth plaque score (0%, 15%, 20%, 100%); FMBS, full mouth bleeding score (0%, 10%, 20%, 100%); number of sites ≥ 5 mm (0, 2, 5, ≥ 10 sites); number of teeth lost (0, 4, 10, >10 teeth lost); mean radiographic bone loss (0, 1, 3, >3 mm); number of systemic diseases with immune response deficiencies (0, 1, 2, >2 systemic diseases); number of cigarettes/day (0, 10, 20, >20 cigarettes); age (>55, 55, 35, 15 years old); microbial pattern (0 = no periodontal pathogen bacteria; 1 = prevalence of *Pg*; 2 = prevalence of *Pg* and *Aa*; 3 = high levels of *Pg*, *Aa*, *Tf*, *Fn*, *Pi* etc.).

establish a proper prognostic evaluation. A further aim is that use of the computerised method also increases patient compliance.

### Study design

Using a standard program for recording anamnestic, clinical and periodontal data, specific software was developed. This software is able to produce a graphic presentation (grid) categorised as follows (Figs 1 to 3):

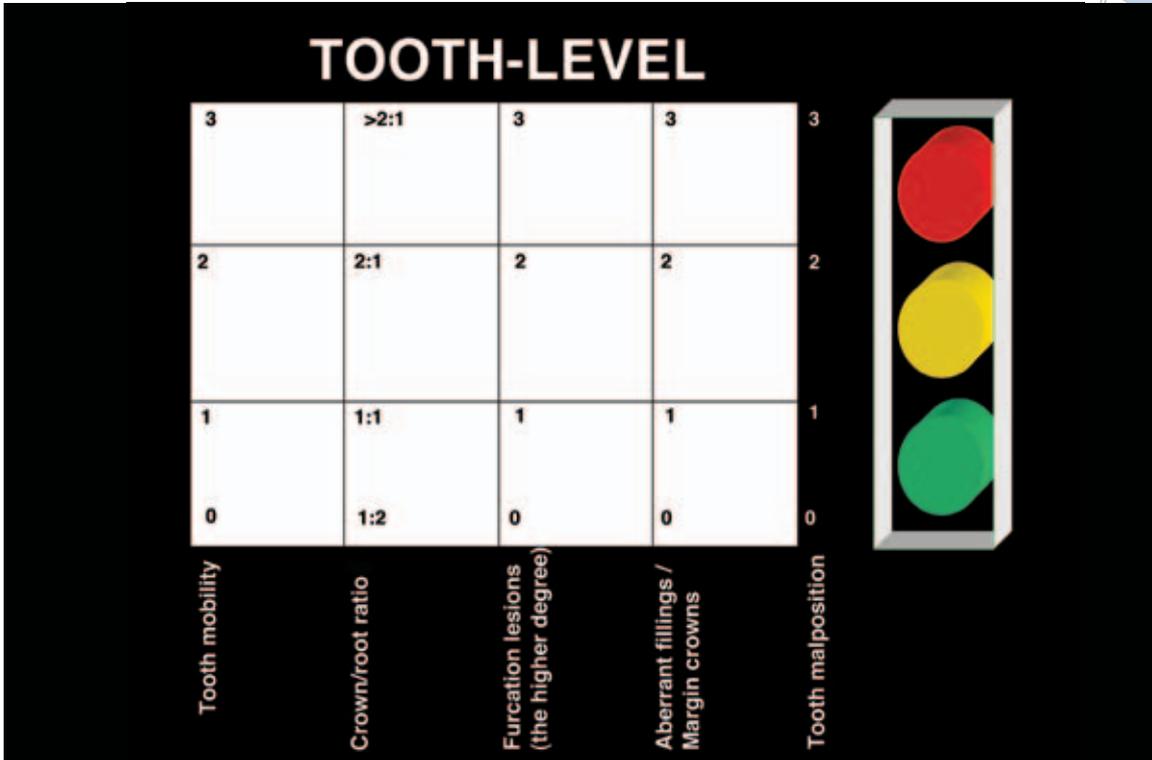
- **Patient-level:** full mouth plaque score, full mouth bleeding score, number of sites with pocket depth ≥ 5 mm, number of lost teeth, mean radiographic bone loss, number of systemic diseases, number of cigarettes smoked per day, age, microbial pattern (optional).
- **Tooth-level:** mobility, crown/root ratio, furcation lesions, aberrant fillings/margin crowns, malposition.

- **Site-level:** gingival recession depth, pocket depth, degree of inflammation.

At each level, the recorded variables present four different degrees of severity that provide three risk levels: low, moderate and high. The program associates a specific colour with each risk level, green (low), amber (moderate) and red (high), and it is graphically represented by a 'traffic light' system. The severity values of each variable are based on data in recent periodontal literature (as reported below); in case of data that were not supported by adequate evidence, the severity values were attributed by combining present insufficient evidence with clinical data, and evaluating the clinical relevance of these variables.

The software only provides the traffic light system if all the requested variables are recorded.

The three levels and the related variables are described below.



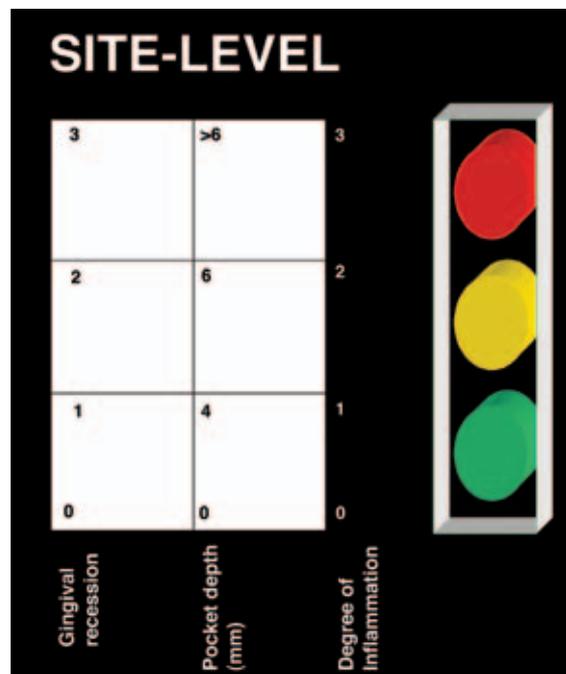
**Fig 2** Tooth-related records. Tooth mobility (0, 1, 2, 3 according to Nyman and Lindhe<sup>32</sup> classification); crown/root ratio (1:2, 1:1, 2:1, >2:1); Furcation lesions (0, 1, 2, 3 according to Hamp<sup>36</sup> classification); aberrant fillings/margin crowns (0 = no aberrant fillings/margin crowns, 1 = presence of only aberrant fillings/margin crowns, 2 = aberrant fillings/margin crowns with associated bleeding on probing and pocket depth ≤ 4 mm, 3 = aberrant fillings/margin crowns with associated bleeding on probing and pocket depth > 4 mm); tooth malposition (0 = no tooth malposition, 1 = presence of tooth malposition without marginal bacterial plaque, 2 = presence of tooth malposition and bacterial plaque, 3 = presence of tooth malposition with bacterial plaque and bleeding on probing).

## ■ Patient-related records

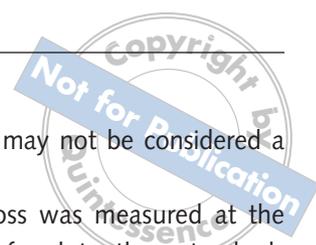
### ■ Percentage of full mouth plaque score (% FMPS)

This is one of the most important factors for establishing each patient's compliance level and planning treatment<sup>7,8</sup>. Although there is no established acceptable level of prevalence of plaque infection, Lang & Tonetti<sup>6</sup> reported that a range between 20% and 40% of plaque accumulation might be tolerable for most patients in a clinical setting. However, a FMPS of 15% is considered the cut-off for performing specific surgical procedures, such as guided tissue regeneration<sup>9</sup>.

In the rating system, 0% indicates absence of plaque, with 15%, 20%, and >40% indicating an increased percentage of plaque accumulation. Consequently the risk levels are: green (low) 0–15%, amber (moderate) >15–40%, and red (high) > 40–100%.



**Fig 3** Site-related records. Gingival recession (0 = no gingival recession; 1 = Miller's class I and II; 2 = Miller's class III; 3 = Miller's class IV); pocket depth (0, 4, 6, >6 mm); degree of inflammation (0 = no bleeding on probing; 1 = presence of bleeding on probing; 2 = presence of bleeding on probing and sup-puration with pocket depth <5 mm; 3 = presence of bleeding on probing and sup-puration with pocket depth ≥5 mm).



■ **Percentage of full mouth bleeding score (% FMBS)**

As yet, a percentage above which there is a higher risk for disease recurrence has not been identified. The percentage of full mouth bleeding on probing of 25% is the cut-off point commonly reported<sup>10-12</sup>. However, 15% of FMBS is considered the cut-off value to perform specific surgical procedures, such as guided tissue regeneration<sup>9</sup>. In the rating system, 0 indicates absence of bleeding on probing, with 15%, 20% and >20% indicating an increased percentage of inflammation/infection. Consequently the risk levels are: green (low) 0-15%, amber (moderate) >15-20%, and red (high) >20-100%.

■ **Number of sites with pocket depth ≥5 mm**

The presence of multiple probing depths ≥5 mm in patients during supportive periodontal care revealed a greater risk of developing sites with additional attachment loss than in patients with few and shallow probing depths<sup>13</sup>. Nevertheless, there are no data indicating the risk of progression/recurrence of disease in relation to the number of deep pockets.

Therefore, the rating system is 0 (no periodontal pockets ≥5 mm), 2, 5, and ≥10 sites with pocket depth ≥5 mm. Consequently the risk levels are: green (low) 0-2, amber (moderate) 3-5, and red (high) ≥6.

■ **Number of teeth lost**

Several articles suggest a possible relationship between tooth loss and further tooth loss over time<sup>14,15</sup>. The number of lost teeth and the proportion of plaque scores was reported to be a significant predictive value for further alveolar bone loss.

The scoring system is 0 (no lost teeth), 4, 10, >10 lost teeth. Consequently the risk levels are: green (low) 0-4, amber (moderate) 5-10, and red (high) >10.

■ **Mean radiographic bone loss**

Patients with advanced alveolar bone loss are generally at higher risk for tooth loss than patients with lower amounts of bone loss<sup>16-19</sup>, even if residual pe-

riodontal support per se may not be considered a negative factor.

Radiographic bone loss was measured at the mesial and distal surface of each tooth on standardised periapical radiographs using a periodontal probe<sup>20,21</sup>. Therefore, the assigned scores are 0 mm (physiologic level of the bone margin with respect to the cemento-enamel junction), 1 mm, 3 mm, >3 mm. Consequently the risk levels are: green (low) 0-1 mm, amber (moderate) 2-3 mm, and red (high) >3 mm of bone loss.

■ **Number of systemic diseases with immune response deficiency**

Systemic diseases characterised by a deficiency of the immune response, such as diabetes, stress and neutropenia<sup>17,22-25</sup>, are considered potential risk factors for periodontitis. The presence of one or more systemic diseases may be indicative of a higher probability of the progression/recurrence of periodontitis.

The scores assigned for evaluating systemic diseases are 0, indicating absence of systemic disease, 1, 2, and >2 systemic diseases, indicating an increased risk probability. Consequently the risk levels are: green (low) 0, amber (moderate) 1, red (high) ≥2.

■ **Number of cigarettes/day**

Tobacco smoking is a true risk factor for periodontitis. A dose-related effect between the number of cigarettes smoked and severity of the disease/response to the therapy has been reported<sup>26,27</sup>.

The adopted scores range are 0, indicating no smoking habits, 10, 20, and >20 cigarettes smoked per day. Consequently the risk levels are: green (low) 0-10, amber (moderate) 11-20, and red (high) >20.

■ **Age**

It is not yet clear whether age is related to a deteriorating periodontium or whether the deterioration is related to other unknown age-related factors<sup>28</sup>. A young patient with periodontitis seems to be at higher risk in terms of loss of attachment/tooth than an adult patient. Therefore, the scores are >55 to 55, 35 and 15. The risk levels are: green (low) ≥55 years old, amber (moderate) 54-35, red (high) 34-15 years old.



## ■ Microbial pattern

The main indication for the use of microbiological diagnostic tests is for those patients who do not respond to conventional mechanical therapies during the maintenance phase<sup>29</sup>. For this reason, in contrast to other variables, the recording of these data is not obligatory. Several microbiological tests have been used. Real-time PCR analysis shows the highest specificity and sensitivity for identifying specific microbiota (*Actinobacillus actinomycetemcomitans* (Aa), *Porphyromonas gingivalis* (Pg) and *Tannerella forsythensis* (Tf)) recognised as periodontal pathogens.

Therefore, the scores are: 0, no periodontal pathogen bacteria; 1, low prevalence of Pg; 2, prevalence of Pg and Aa; and 3, high levels of Pg, Aa, Tf, *Fusobacterium nucleatum* (Fn), *Prevotella intermedia* (Pi) etc. Consequently the risk levels are: green (low) 0–1, amber (moderate) 2, and red (high) 3.

## ■ Tooth-related record

### ■ Tooth mobility

Tooth mobility seems to be a greater risk for tooth loss after 2-year follow-up for teeth with a mobility score  $\geq 2$  than those with mobility  $< 2$ <sup>30,31</sup>.

The considered scores are based on the Nyman and Lindhe classification<sup>32</sup> (scores 0, 1, 2 and 3). The risk levels are: green (no/low risk) 0–1, amber (moderate risk) 2, and red (high risk) 3 score.

### ■ Crown/root ratio

The radiographic ratio between the portion of the tooth outside of the alveolar bone (known as the crown) with respect to the portion inside the alveolar bone (root) is another factor that should be recorded and evaluated<sup>19,33</sup>.

Due to the lack of data about this factor, ratios used are 1:2, 1:1, 2:1, and  $>2:1$ . Consequently the risk levels are: green (low) 1:2 to 1:1, amber (moderate) 2:1, and red (high)  $>2:1$ .

## ■ Furcation lesions

Previous studies show that affected multi-rooted teeth appear to be at high risk for tooth loss over time<sup>18,34,35</sup>.

The evaluating scores are based on the Hamp classification<sup>36</sup> (class 0, 1, 2 and 3). The risk levels are: green (no/low risk) 0–1, amber (moderate risk) 2, red (high risk) 3. In case of teeth with more than one furcation involved, the software is set to consider the highest score reported by the single tooth.

## ■ Aberrant fillings/margin crowns

An unfitted margin of restorations/prosthesis should be considered as a retention factor for dental plaque<sup>37,38</sup>.

The considered scores are: 0, no aberrant fillings/margin crowns; 1, presence of only aberrant fillings/margin crowns; 2, aberrant fillings/margin crowns with associated bleeding on probing and pocket depth  $\leq 4$  mm; and 3, aberrant fillings/margin crowns with associated bleeding on probing and pocket depth  $>4$  mm. The relative risk levels are: green (no/low risk) 0–1, amber (moderate risk) 2, red (high risk) 3 score.

## ■ Tooth malposition (mesial tipping, rotation, inclination)

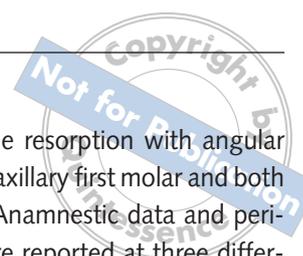
Tooth malposition may impair oral hygiene practices and favour plaque accumulation. A worsening prognosis has been reported for malpositioned teeth<sup>18</sup>.

The considered scores are: 0, no tooth malposition; 1, presence of tooth malposition without marginal bacterial plaque; 2, presence of tooth malposition and bacterial plaque; and 3, presence of tooth malposition with bacterial plaque and bleeding on probing. The relative risk levels are: green (no/low risk) 0–1, amber (moderate risk) 2, and red (high risk) 3.

## ■ Site-related records (Fig 3)

### Gingival recession

Gingival recession is not a critical factor for tooth survival, although it is considered a prognostic factor for predicting treatment outcome following root coverage procedures<sup>39</sup>.



The scores are based on Miller's classification<sup>40</sup>: 0, no gingival recession; 1, class I and II; 2, class III; and 3, class IV.

### Pocket depth

The presence of deep pockets is considered as a risk indicator for the progression of periodontitis<sup>6,9-12,41</sup>.

The adopted scores are: 1, 4, 6 and >6 mm of pocket depth<sup>41</sup>. The relative risk levels are: green (no/low risk) 1–4 mm, amber (moderate risk) 5–6 mm, and red (high risk) >6 mm.

### Degree of inflammation

Gingival inflammation represents an increased probability of disease progression. Deepening of pocket depth, persistent bleeding on probing, and presence of suppuration indicate a high risk of loss of attachment<sup>11-13</sup>. Therefore, the scores used for this variable are: 0, no bleeding on probing; 1, presence of bleeding on probing; 2, presence of bleeding on probing and suppuration with pocket depth < 5 mm; and 3, presence of bleeding on probing and suppuration with pocket depth ≥ 5 mm. The relative risk levels are: green (no/low risk) 0–1, amber (moderate risk) 2, and red (high risk) 3.

## ■ Results

### ■ Clinical application

A single clinical case illustrates the application of the described software. All the patient level data are reported, while tooth and site level data are limited to one example each.

A 42-year-old female with periodontal disease underwent a periodontal evaluation in a private office. She was suffering from controlled, non-insulin-dependent diabetes mellitus and smoked an average of 12 cigarettes per day. A relevant malocclusion with bilateral cross-bite was present. Several teeth were malpositioned, with tooth crowding in the anterior region of the mandible and maxilla. Plaque accumulation, gingival inflammation, periodontal pockets and tooth mobility were present. From the radiograph it was possible to observe the presence of

a horizontal alveolar bone resorption with angular bone defects at the left maxillary first molar and both mandibular first molars. Anamnestic data and periodontal measurements are reported at three different levels.

Patient-level (Fig 4):

- Full mouth plaque score: 87%
- Full mouth bleeding score: 74%
- Number of sites with pocket depths ≥ 5 mm: 7
- Number of lost teeth: 2
- Mean radiographic bone level: 4 mm
- Number of systemic diseases: 1 (diabetes)
- Number of cigarettes smoked per day: 12
- Age: 42 years old
- Microbial pattern: high level of *Pg*, *Aa*, *Tf*, *Fn*, *Pi*, *Pm*.

Tooth-level (left maxillary central incisor) (Fig 5):

- Tooth mobility: score 1
- Crown/root ratio: 2:1
- Aberrant fillings/margin crowns: no
- Tooth malposition: score 3 (malposition + presence of bacterial plaque + bleeding on probing)

Site-level (middle buccal site/right mandibular canine) (Fig 6):

- Gingival recession: no
- Pocket depth: 6 mm
- Degree of inflammation: score 3 (bleeding on probing + suppuration + pocket depth ≥ 5 mm)

### ■ Treatment

On the basis of this evaluation, the patient was instructed and motivated to perform proper oral hygiene procedures. After scaling and root planing, tooth extractions (teeth 1, 12, 17, 21, 29, 32 according to FDI numbering system) were performed to create space as required by the orthodontic treatment plan. Periodontal surgery (resective surgery and open flap debridement) was performed in different quadrants of the mouth. Three months after surgery the patient began orthodontic treatment, in order to achieve correct tooth alignment and occlusion. At the end of the active phase of treatment, the patient was enrolled in an appropriate supportive periodontal care programme, with a tailored system of recall visits.

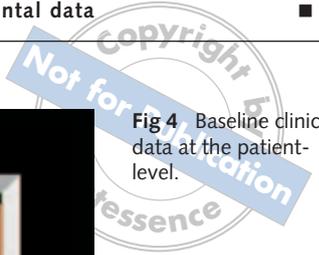


Fig 4 Baseline clinical data at the patient-level.

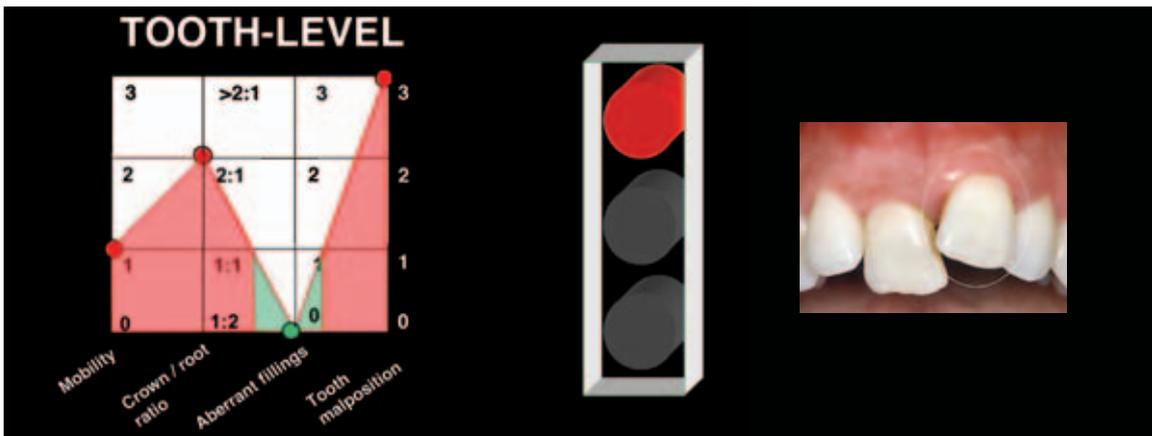


Fig 5 Baseline clinical data at the tooth-level.

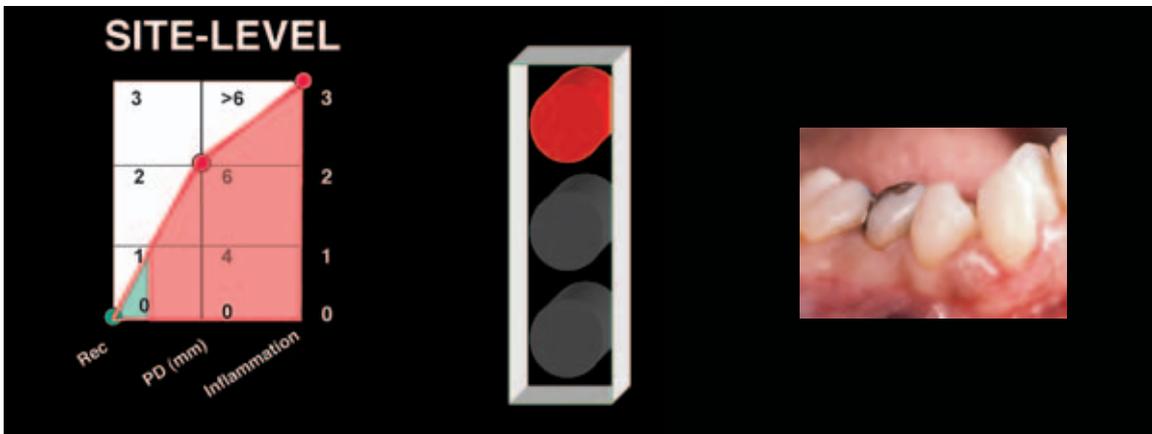


Fig 6 Baseline clinical data at the site-level.

Fig 7 Clinical data at the patient-level 6 months after therapy.

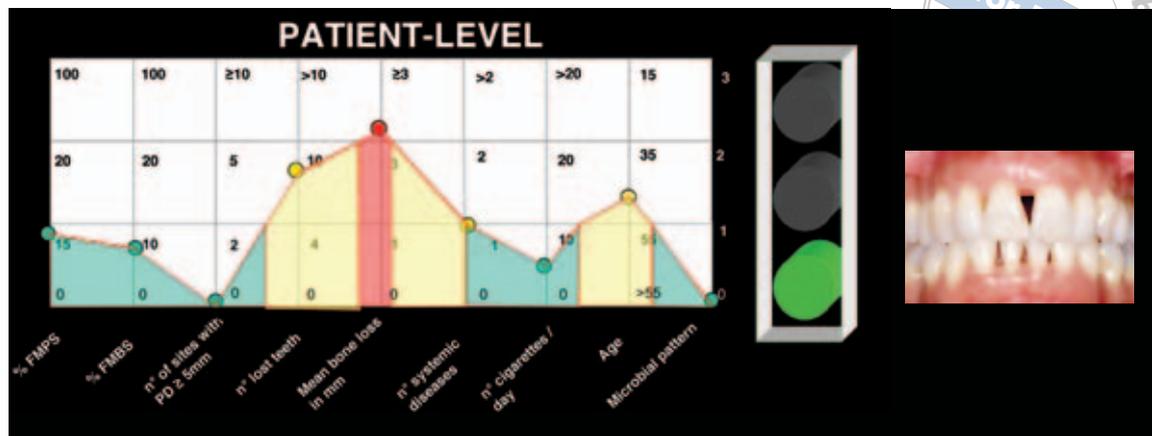
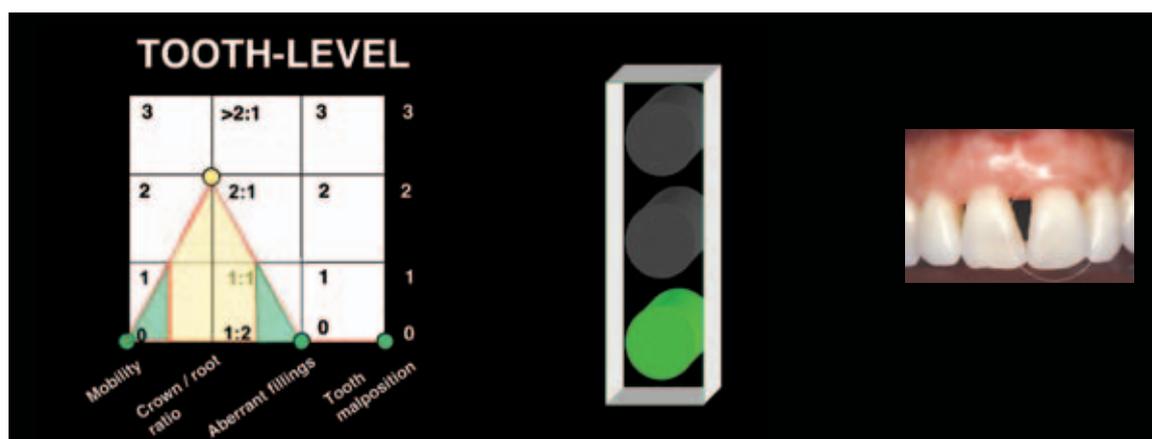


Fig 8 Clinical data at the tooth-level 6 months after therapy.



One year after the completion of the treatment, the patient was re-evaluated and the clinical and periodontal variables considered at the first visit were re-examined.

Patient-level (Fig 7):

- Full mouth plaque score: 13%
- Full mouth bleeding score: 8%
- Number of sites with pocket depths ≥ 5 mm: 0
- Number of lost teeth: 8
- Mean radiographic bone level: 4 mm
- Number of systemic diseases: 1 (diabetes)
- Number of cigarettes smoked per day: 5
- Age: 43 years old
- Microbial pattern: low level of *Fn*

Tooth-level (left maxillary central incisor) (Fig 8):

- Tooth mobility: 0
- Crown/root ratio: 2:1
- Aberrant fillings/margin crowns: no
- Tooth malposition: score 0

Site-level (middle buccal site/right mandibular canine) (Fig 9):

- Gingival recession: no
- Pocket depth: 2 mm
- Degree of inflammation: 0

Fig 10 shows the comparison between the pre- and post-operative risk profile of the patient at each level (patient, tooth and site). Discussing this comparison with the patient is useful for illustrating the results of the treatment and of paramount importance in reinforcing the patient's compliance.

### Discussion

A correct diagnosis is of vital importance in drawing up an appropriate treatment plan and prognosis. Potential/true risk and prognostic factors for periodontal disease should be identified even if some of these

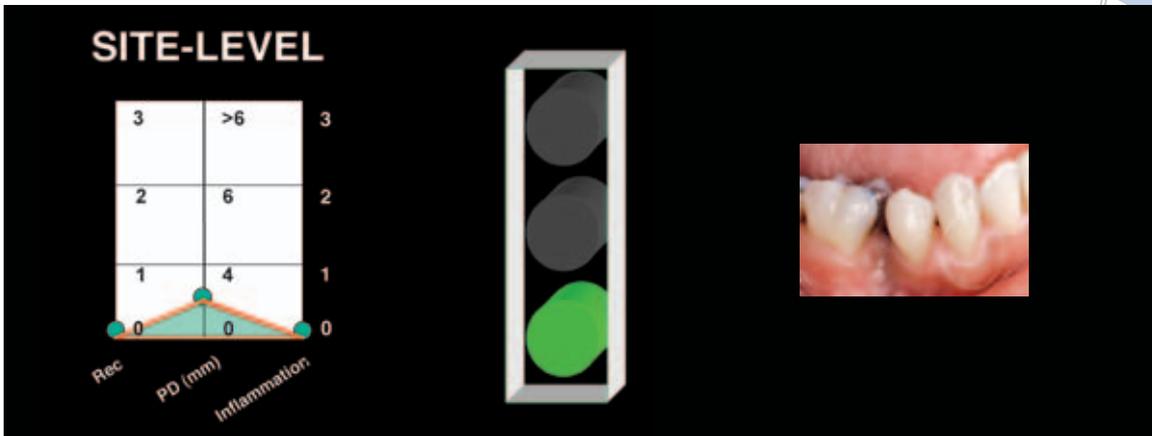
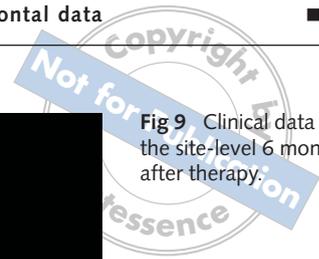


Fig 9 Clinical data at the site-level 6 months after therapy.

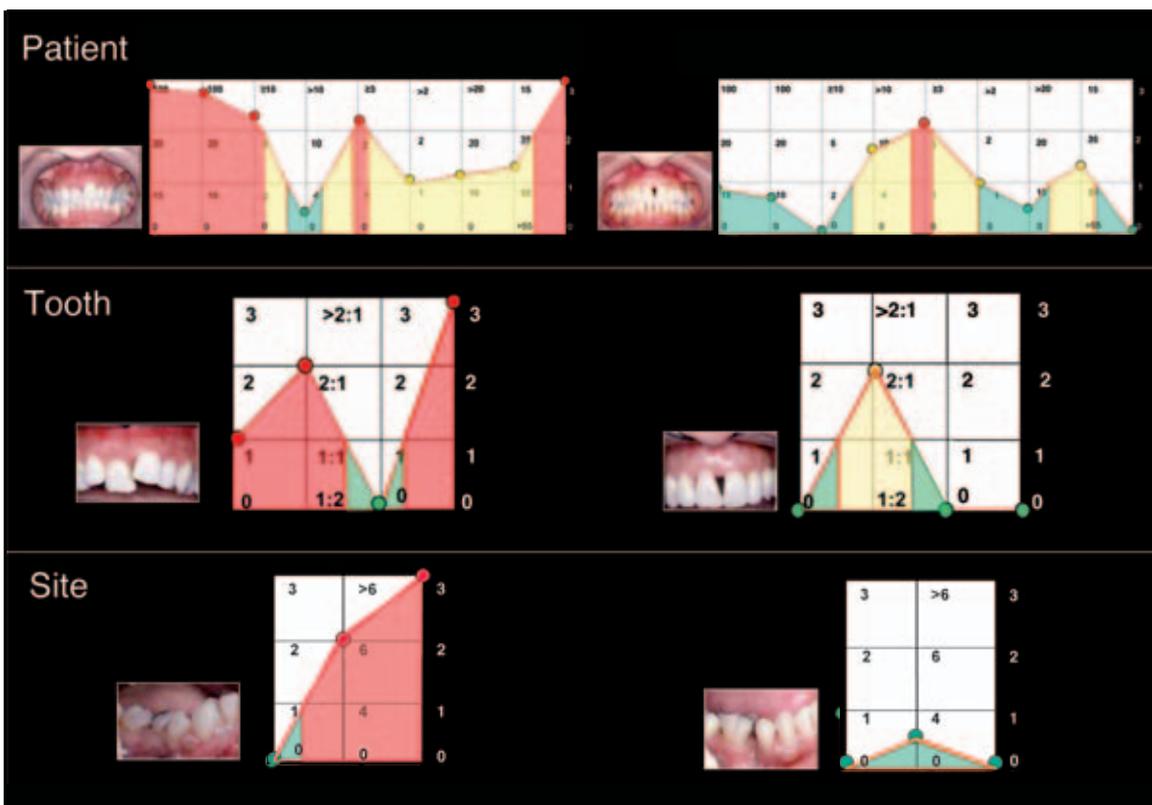
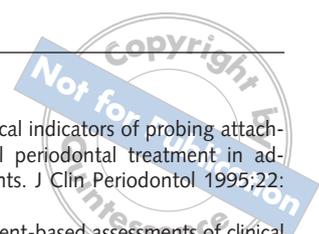


Fig 10 A profile comparison of the patient before and after treatment at patient-, tooth- and site-level using the new recording and evaluating system.

factors are still unclear and need further scientific confirmation.

There are several programs for collecting clinical measurements for purposes of periodontal charting. The aim of this paper is to describe specific software that, starting from a program for collecting all the clinical and periodontal-related data, can develop a patient risk profile. According to the previous suggestions<sup>6</sup>, the risk profile is evaluated at three different levels: patient, tooth and site. At each level, the recorded variables present four different degrees of severity that provide three different risk

levels (low, moderate, high). The electronic/mathematical processing associates a specific colour with each risk degree: green/low, amber/moderate, red/high (traffic light system). The colours represent the final result of the risk evaluation of all considered variables for each level. Therefore, the assessment of a single variable is not necessary. In addition, the software is able to provide a result through the traffic light system if all the requested data have been recorded. Microbiological testing is usually done in cases of poor response to conventional treatment or recurring disease.



Thanks to this self-explanatory graphic representation it is possible to visualise the risk profiles at each level before the therapy and the changes after the treatment.

Most of the considered variables used for the risk evaluation were chosen on the basis of current scientific evidence, while others, although not yet supported in the literature, were included in the assessment because of their clinical relevance. This software is in a constant state of evolution because the variables can be modified, new ones added or others deleted depending on future periodontal evidence.

Another important clinical implication of this software is that patients easily understand the images and graphs; they can see their risk level before and after the treatment. This feature may help improve patient compliance.

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