Prevalence and progression of untreated periodontal disease in a young Indonesian population
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HOW DO DATA FROM DEEPEST POCKET PER QUADRANT RELATE TO FULL-MOUTH SCORES?

Progression of untreated periodontal disease in young Indonesians

CHAPTER 7

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CHAPTER 1

DEEP Pockets: Progression of Untreated Periodontal Disease in Young Indigenous Adolescents.
To what extent are scores of a limited number of sites capable of predicting a full-mouth situation? With regard to microbiology, in general a limited number of samples is taken, when the subgingival presence of periodontal pathogens is studied in patients or populations. Mostly, a number of the deepest sites is sampled. Mombelli et al. (1991a, 1991b, 1994) studied the topographic distribution of *Actinobacillus actinomycetemcomitans*, *Porphyromonas gingivalis* and *Prevotella intermedia* within the dentition of periodontitis patients. The highest chance of detecting *A. actinomycetemcomitans*, *P. gingivalis* and *P. intermedia* existed in deep pockets, which bled upon sampling. In a subsequent investigation, selection of the deepest pocket in each quadrant appeared to be the most efficient method of sampling for detecting *P. gingivalis*. Studies evaluating the effect of periodontal therapy both clinically and microbiologically have used the mean of the deepest site per quadrant (4-sites) to describe the patient’s response (Loesche et al. 1985, Rams et al. 1990, Goené et al. 1990, Rodenburg et al. 1990, Van Winkelhoff et al. 1992, Pavičić et al. 1994, Winkel et al. 1997, Shiloah et al. 1998, Takamatsu et al. 1999). The mean of a small number of deep sites as the only patient level variable is also frequently used (Matisko & Bissada 1993, Bollen & Quirynen 1996, Renvert et al. 1996, 1998, Eggert et al. 1998a, 1998b). However, the question arises whether 4 deep sites, i.e. the deepest site per quadrant, can be regarded representative as to what occurs to the periodontium on a full-mouth level. In other words, do these 4 sites reflect the full-mouth periodontal condition of a periodontitis patient? It is obvious, that both in natural disease and in the evaluation of treatment, due to the selection procedure, a systematic difference between the full-mouth measurement and the deepest-site measurement can be expected. However, estimation of the full-mouth score, calculated on the basis of the deepest-site measurement could be possible. If a certain level of predictability is presumed, the full-mouth mean value may be expressed as the outcome of a simple regression equation. When using such a procedure to predict the full-mouth parameter, the 95% prediction interval of the outcome is
approximated by the following statement:

\[ y_{\text{(full-mouth)}} = (a \times x_{\text{(4-sites)}} - b) \pm 2SD_{\text{(residual)}} \]

where \( y \) is the full-mouth parameter, \( x \) is the 4-sites measurement, \( a \) is the regression coefficient, \( b \) is the constant and \( SD_{\text{(residual)}} \) is the residual standard deviation of the regression analysis. If this residual standard deviation is small, the 4-sites measurement can be used to predict the full-mouth measurement.

A sound study design to investigate this supposition is the model of progression of untreated periodontitis. In this model no effect of preventive measures and treatment is present, which may influence the data to an extent that cannot be controlled for. Data of a longitudinal investigation on untreated periodontal disease were used to assess the magnitude of the residual standard deviation of the regression analysis. In this data set both the 4-sites and full-mouth data were obtained. Therefore, the purpose of the present retrospective study was to investigate to what extent the natural progression of periodontitis as measured in the deepest approximal pocket in each quadrant reflects the disease progression at the approximal sites on a full-mouth level.

**MATERIALS AND METHODS**

**Study population**
The study population was obtained from the Malabar/Poerbasari tea estate on Western Java, Indonesia and was described in earlier reports (Van der Velden et al. 1993, 1996, Timmerman et al. 1998, 2000, 2001, Van Winkelhoff et al. 1999). In 1987 a baseline evaluation was performed (Timmerman et al. 1998). All subjects (\( N = 255 \)) in the age range 15 - 25 years from the village of Srikandi participated in this investigation.

The follow-up assessment was performed in 1994 and included 158 members (69 male, 89 female) of the original group. Clinical measurements were performed as described in detail previously (Timmerman et al. 1998, 2000, 2001). Plaque (Silness & Löe 1964), Bleeding on Probing (BOP; Van der Velden 1979), Pocket Depth (PD) and Attachment Loss (AL) were recorded at all approximal surfaces from the vestibular aspect.
Data analysis
The clinical parameters as assessed at all approximal surfaces at baseline and follow-up were calculated as full-mouth mean scores per patient. Furthermore, means of the clinical parameters were calculated for the 4 sites that had originally been selected for microbiological analysis at the follow-up assessment in 1994, i.e. the deepest pocket in each quadrant that showed the most attachment loss and bleeding on probing (Timmerman et al. 2001). Since one of the selection criteria for the 4 test sites was bleeding on probing, for the present study no further analysis on the BOP was performed. A regression analysis was used to evaluate the relationship between full-mouth score and the 4 sample sites concerning progression of disease with regard to PD, AL and plaque. This analysis provided, apart from the correlation coefficient between the full-mouth value and the 4-sites measurement and the slope of the regression line (the regression coefficient), the residual standard deviation.
To analyze the relation between full-mouth scores and 4-site scores at follow-up, the same procedure was performed.

RESULTS
Table 1 describes disease progression from the baseline clinical assessment in 1987 to the follow-up assessment in 1994. No difference was found between 4-sites and full-mouth for the increase in plaque scores ($p = 0.73$). A significant increase in PD was observed at the 4 sites, but not at the full-mouth level PD. An increase in AL was found both at the 4-sites and the full-mouth level. The increase in AL measured at the 4-sites was larger. Significant correlation coefficients were observed between the 4-sites and full-mouth mean changes (PD: 0.80, AL: 0.70, PI: 0.77). Regression coefficients were 0.51 for pocket depth, 0.35 for attachment loss and 0.55 for plaque. The precision of the estimate for the full-mouth mean as predicted by the 4-site method in the same subject is determined by the residual standard deviation of the regression analysis. This was for pocket depth 0.31 mm, for attachment loss 0.31 mm and the residual standard deviation for plaque score was 0.29.
Table 1. Increments of clinical parameters between 1987 and 1994. Relation between full-mouth approximal and 4-sites evaluation of disease progression

<table>
<thead>
<tr>
<th></th>
<th>Full-mouth mean (SD)</th>
<th>4-sites* mean (SD)</th>
<th>Correlation coefficient</th>
<th>Regression Coefficient (SE)</th>
<th>Residual Stand. dev. (SE)</th>
<th>Intercept (SE)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Probing depth</td>
<td>0.08 (0.51)</td>
<td>0.68 (0.82)</td>
<td>0.80</td>
<td>0.51 (0.03)</td>
<td>0.31</td>
<td>-0.26 (0.03)</td>
<td>0.60</td>
<td>**</td>
</tr>
<tr>
<td>Attachment loss</td>
<td>0.39 (0.44)</td>
<td>1.02 (0.89)</td>
<td>0.70</td>
<td>0.35 (0.03)</td>
<td>0.31</td>
<td>0.04 (0.04) ns</td>
<td>0.72</td>
<td>**</td>
</tr>
<tr>
<td>Plaque score</td>
<td>0.15 (0.45)</td>
<td>0.14 (0.62)</td>
<td>0.77</td>
<td>0.95 (0.04)</td>
<td>0.29</td>
<td>0.07 (0.02)</td>
<td>0.64</td>
<td>**</td>
</tr>
</tbody>
</table>

* The 4-sites mean was determined as mean value of clinical parameters of the deepest, bleeding pocket in each quadrant showing the greatest amount of attachment loss.

** SD_{residual} / SD_{full-mouth} = \sqrt{(n-1)/(n-2)) * \sqrt{(1-r^2)}.

Table 2. Relation between full-mouth approximal and 4-sites mean values for clinical parameters at the follow-up visit

<table>
<thead>
<tr>
<th></th>
<th>Full-mouth mean (SD)</th>
<th>4-sites* mean (SD)</th>
<th>Correlation coefficient</th>
<th>Regression Coefficient (SE)</th>
<th>Residual Stand. dev. (SE)</th>
<th>Intercept (SE)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Probing depth</td>
<td>3.33 (0.50)</td>
<td>4.39 (0.85)</td>
<td>0.86</td>
<td>0.51 (0.02)</td>
<td>0.26</td>
<td>1.12 (0.11)</td>
<td>0.51</td>
<td>**</td>
</tr>
<tr>
<td>Attachment loss</td>
<td>0.75 (0.57)</td>
<td>1.74 (1.00)</td>
<td>0.83</td>
<td>0.48 (0.03)</td>
<td>0.32</td>
<td>-0.08 (0.05) ns</td>
<td>0.56</td>
<td>**</td>
</tr>
<tr>
<td>Plaque score</td>
<td>1.16 (0.39)</td>
<td>1.41 (0.54)</td>
<td>0.62</td>
<td>0.44 (0.05)</td>
<td>0.31</td>
<td>0.54 (0.07)</td>
<td>0.79</td>
<td>**</td>
</tr>
</tbody>
</table>

* The 4-sites mean was determined as mean value of clinical parameters of the deepest, bleeding pocket in each quadrant showing the greatest amount of attachment loss.

** SD_{residual} / SD_{full-mouth} = \sqrt{(n-1)/(n-2)) * \sqrt{(1-r^2)}. 
Table 2 shows the clinical parameters at the follow-up assessment in 1994. The difference between the full-mouth and 4-site measurement was 1.06 mm for PD, 0.99 mm for AL, and 0.25 for PI. High correlation coefficients were observed between the two measurements (PD: 0.86, AL: 0.83, PI: 0.62). All coefficients were statistically significant. Regression coefficients were 0.51 for pocket depth, 0.48 for attachment loss and 0.54 for plaque. The residual standard deviation for pocket depth was 0.26 mm, for attachment loss 0.32 mm and for the plaque score 0.31.

DISCUSSION

The present study uses a data set of a longitudinal evaluation of prevalence and progression of periodontitis in a young Indonesian population. The prevalence of periodontal attachment loss in this population can be considered high, as was described in earlier reports (Timmerman et al. 1998, 2000). In agreement with other epidemiological studies, attachment loss was present throughout the entire dentition. The first upper molars, upper and lower incisors were the teeth most frequently affected (Löe et al. 1978a, 1978b, Baelum et al. 1988, Timmerman et al. 1998). After the 7 years evaluation period the first molars and incisors were still the teeth most frequently affected. However, disease progression was observed more evenly distributed throughout the dentition (Timmerman et al. 2000), making this data set suitable to use for the purpose of the present study.

The results showed relatively high correlation coefficients between the 4-sites and full-mouth data for all clinical parameters. However, data sets that show quite high correlations may well be in poor agreement (Bland & Altman, 1986). It is of course not possible to exchange the full-mouth measurement with the 4-sites measurement, because of the systematic difference, caused by the selection criteria of the 4 sites. Nevertheless, calculation of the full-mouth measurement from the 4-site measurement using the regression equation and determining the 95% confidence interval of the prediction helps to apprehend the accuracy of the estimate. For example, when using the longitudinal data, as presented in Table 1, and taking into consideration the regression coefficients, the full-mouth mean may range from 0.1 mm to 1.4 mm, if an increase in 4-
sites mean measurement of 2 mm attachment loss between baseline and follow-up is observed. Similarly 3 mm increase in attachment loss at 4-sites predicts at a full-mouth level between 0.5 mm and 1.7 mm. This clarifies the necessity for the residual standard deviation to be small, as it is responsible for the range of the 95% confidence interval of the predicted full-mouth mean. What is encountered in this respect in the longitudinal data, also exists in the cross-sectional data, where the full-mouth data are poorly predicted by the mean of 4 worst sites. The residual standard deviations are of the same magnitude as those of the longitudinal results.

Compared to the standard deviation of the longitudinal full-mouth data, the magnitude of the residual standard deviation was approximately 2/3 in size (Table 1). Considering that the residual standard deviation is of such a dimension, the precision of the full-mouth score estimated by the 4-sites measurement in a certain individual, reaches a point where it is as reliable as measuring different subjects from this population. This implicates that the periodontal condition at present or in time, is described inaccurately by the use of a limited number of diseased sites as a subject level variable. The clinical measurements of small numbers of deep sites have been used as patient level descriptors in numerous studies (Loesche et al. 1985, Goené et al. 1990, Rams et al. 1990, Rodenburg et al. 1990, Van Winkelhoff et al. 1992, Matisko & Bissada 1993, Pavičić et al. 1994, Bollen & Quirynen 1996, Renvert et al. 1996, 1998, Winkel et al. 1997, Eggert et al. 1998a, 1998b, Shiloah et al. 1998, Takamatsu et al. 1999). Although, in these studies, the measurements have shown changes in time, the magnitude of these changes is not easily translated into a full-mouth level mean. Furthermore, the phenomenon of regression to the mean might bias the results on these deepest site measurements (Altman 1991). This implies that by selecting sites with the deepest pocket, a high chance of scoring lower values at the second assessment exists.

In conclusion, in the present population, a reasonable to good correlation between full-mouth and 4-sites data was observed. However, the high residual standard deviation in the regression analysis illustrates the inaccuracy for the 4-site data, when used as a descriptive for changes in the periodontal condition on a full-mouth level. Data evaluating progression of periodontitis based on a limited number of diseased sites should be interpreted cautiously.
REFERENCES


