

Proximal alveolar bone loss in a longitudinal radiographic investigation

III. Some predictors with a possible influence on the progress in an unselected material

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The difference in proximal alveolar bone height between 1970 and 1980, the 'ABD index', has been measured longitudinally in radiographs from an unselected material. The group constitutes 406 individuals born in 1904-1952 in the county of Stockholm. Thirteen of 18 predictors determined in 1970 were significantly related to the ABD index in the simple correlation analyses. The predictor 'the alveolar bone loss 1970' ('ABL index 1970') had the strongest correlation to the ABD index. In the stepwise multiple regression analysis the predictor ABL index 1970 and three other predictors reached significant levels. These were age, number of lost teeth, and Russell's Periodontal Index. □ *Epidemiology; periodontal diseases; periodontal index; prognosis*

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The progress of destructive periodontitis is influenced by many factors. Omitting generalized diseases, some main factors are improper oral hygiene, amount of plaque and calculus, and age (1-4). It has been suggested that 90% of the extent of periodontitis in terms of Russell's Periodontal Index could be explained by age and oral hygiene (1).

The development of destructive periodontitis in a population can be estimated by longitudinal investigations using periodontal probe measurements (5-8). By means of longitudinal radiographic investigations the progress of the periodontal disease can be evaluated in terms of differences in alveolar bone height over time (4, 9-14). In the investigations mentioned the materials had been selected in some manner. In a previously published paper we evaluated the alveolar bone height difference over a 10-year period in an unselected material (15). The baseline data included information not only from radiographs but also from clinical examinations and interviews. The purpose of the present investigation was to analyze factors with a possible influence on the progress of alveolar bone loss in the unselected material.

Materials and methods

The material was the same as described in the previously published paper about a 10-year follow-up study in an epidemiological investigation (15). The material for the analyses consisted of 406 dentate individuals aged 18-65 years in 1970. Participation in the investigation was not associated with any dental treatment. The subjects received the average dental treatment given during the seventies in the region (the old county of Stockholm). All individuals constituting the material were in 1970 and in 1980 examined radiographically, clinically, and by interview about dental care habits, smoking habits, and frequency of dental treatment. The 1970 alveolar bone loss (ABL) was recorded as 10% scores of the root length (15). The mean ABL value for each individual was called the 'ABL index 1970'. The difference in alveolar bone height during the 10-year period (ABD) was measured in tenths of a millimeter and expressed as percentage of the root length. The assessment procedure, including the examination errors, has been described in a previous paper (15). A partial recording index, 12 m, 11 m, 33 d, 31 d, and

Table 1. Variables with quantifications, mean values, and standard deviations (SD) used in the statistical analyses. V1-V18 refer to the 1970 investigation. Reference numbers in parentheses. $N = 406$

Variable	Units and quantifications	Mean	SD
V1 Sex	Male = 1, female = 0	0.498	0.501
V2 Age	18-65 years	36.8	12.8
V3 Social class	Upper = 1, middle = 2, working = 3	2.20	0.70
V4 Tooth brushing frequency	Less than once a day = 0, once a day = 1, twice a day or more = 2	1.77	0.52
V5 Tooth-brushing technique	Two dummy variables: a) Horizontal strokes = 1, other methods = 0	0.094	0.292
V6 Tooth-brushing technique	b) Vertical strokes or roll technique = 1, other methods = 0	0.576	0.495
V7 Smoking, general	Smoking = 1, no smoking = 0	0.522	0.500
V8 Smoking, quantified	No smoking = 0, 1-9 cigarettes/day = 1, 10-19 cigarettes/day = 2, >19 cigarettes/day = 3. One pipe fill = 1 cigarette = 1 g tobacco, according to Pindborg (17)	1.12	1.21
V9 Frequency of dental treatment	At least one treatment/year = 0, more seldom = 1	0.266	0.442
V10 Number of lost teeth	0-31	7.12	5.54
V11 DMFT	0-32	22.18	5.04
V12 Partial dentures	If present = 1, if not = 0	0.054	0.227
V13 No. of periradicular destructions	No. of periradicular destructions divided by no. of remaining teeth	0.055	0.082
V14 Plaque index	DI-S in OHI-S index, Greene & Vermillion (18)	1.55	0.70
V15 Calculus index	CI-S in OHI-S index, Greene & Vermillion (18)	1.27	0.72
V16 OHI-S index	Greene & Vermillion (18)	2.82	1.35
V17 Periodontal index	PI according to Russell (19)	2.39	1.67
V18 Proximal alveolar bone loss index	ABL index (9)	12.0	8.3

41 m. was used (16), and the mean alveolar bone difference for an individual was called the 'ABD index'. No substitution for the sites of the index was used. The alternative to the partial recording was total recording. In a previous paper (15) the mean and standard deviation of the ABD index, expressed as percentage of the root length, was 5.5 ± 4.99 . The ABD index constitutes the dependent variable.

Only variables recorded in 1970 were used when analyzing the causality of alveolar bone loss during the period. All these independent variables (V1-V18) used in the regression analysis are shown in Table 1.

The statistical methods used were frequency calculations, simple correlation analyses, and stepwise multiple regression

analyses. In the stepwise analyses only variables attaining the 1% significance level were included. A residual analysis of the model obtained from the stepwise regression analysis was performed to detect non-linearity.

Results

Mean values and standard deviations for the 18 independent variables used in the analyses are shown in Table 1. Some of the simple correlation coefficients between variables in the analysis are shown in Table 2. Most of the correlations given in the table are significant. Thirteen of the 18 predictors determined in 1970 were significantly related to the ABD index ($p < 0.01$).

Table 2. Correlation coefficients for the comparison between alveolar bone difference 1980–1970 (ABD index) and the variables used in the stepwise multiple regression analysis. V1–V18 refer to the 1970 investigation. Significance limits: $p < 0.05$; $r > 0.098$; $p < 0.01$; $r > 0.128$; and $p < 0.001$; $r > 0.164$. $N = 406$

	ABD index	V18	V2	V10	V17
V18 ABL index	0.58	1.00	0.61	0.56	0.72
V17 PI	0.50	0.72	0.49	0.47	1.00
V10 No. of lost teeth	0.41	0.56	0.57	1.00	0.47
V16 OHI-S index	0.39	0.57	0.42	0.45	0.74
V15 Calculus index	0.39	0.59	0.46	0.46	0.73
V14 Plaque index	0.36	0.49	0.34	0.40	0.68
V13 No. of periradicular destructions	0.24	0.37	0.30	0.30	0.38
V2 Age	0.24	0.61	1.00	0.57	0.49
V12 Partial dentures	0.20	0.25	0.24	0.37	0.18
V11 DMFT	0.16	0.19	0.25	0.32	0.25
V9 Frequency of dental treatment	0.15	0.10	0.00	0.25	0.18
V8 Smoking, quantified	0.15	0.09	-0.20	0.05	0.12
V7 Smoking, general	0.14	0.04	-0.23	-0.01	0.07
V4 Tooth brushing frequency	-0.07	-0.03	-0.03	-0.08	-0.15
V5 Horizontal brushing technique	0.06	0.08	0.09	0.06	0.02
V3 Social class	0.06	0.04	-0.09	0.21	0.07
V1 Sex	0.03	0.10	-0.01	-0.03	0.11
V6 Vertical or roll brushing	0.01	0.02	-0.03	-0.02	0.03

The results of the first multiple regression analysis are shown in Table 3. The predictor that had the strongest correlation to the ABD index was the ABL index 1970—that is, the initial alveolar bone loss in 1970. In second and third place follow the variables age and number of lost teeth, the former with negative sign ($p < 0.001$). The predictor Russell's Periodontal Index was also significant in the analysis ($p < 0.01$). The square of the multiple correlation coefficient, R^2 , the coefficient of determination, was 0.40. None of the other predictors reached

even the 20% significance level. The first predictor of the analysis, the ABL index 1970, had an R^2 value of 0.34.

In the second regression analysis all predictors except the OHI-S index, which is a summation of the plaque index and the calculus index, were used without regard for the significance levels. The result was a slight increase of the coefficient of determination, R^2 , which reached the value 0.42.

For the variables number of lost teeth and ABL index 1970 the residual analysis indicated a departure from linearity; we

Table 3. Stepwise multiple regression analysis with alveolar bone difference 1980–1970 (ABD index) as the dependent variable, and V1–V18 in Table 1 as predictors. V1–V18 refer to the 1970 investigation. $N = 406$

Predictors	Regression coefficient	SE	t	Significance
ABL index	0.323	0.040	8.08	$p < 0.001$
Age	-0.106	0.020	-5.22	$p < 0.001$
No. of lost teeth	0.175	0.045	3.90	$p < 0.001$
Russell's Periodontal Index	0.535	0.167	3.19	$p < 0.01$
Intercept	3.200			

$R^2 = 0.40$.

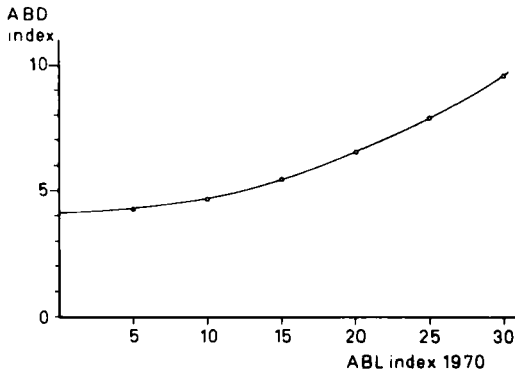


Fig. 1. The curve illustrates the relationship between the ABL index 1970 and the ABD index. The curve is based on the regression analysis giving the equation: $ABD\ index = 4.07 + 0.00615 (ABL\ index\ 1970)^2$, when mean values of age, PI, and number of lost teeth were used (Table 1).

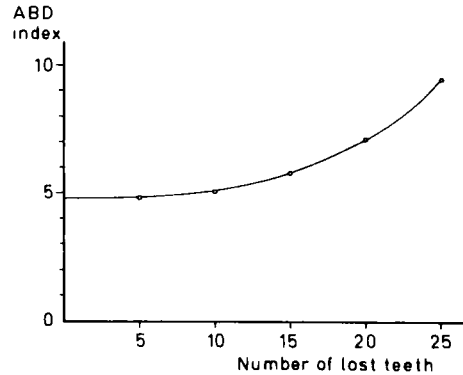


Fig. 2. The curve illustrates the relationship between the number of lost teeth and the ABD index. The curve is based on the regression analysis giving the equation: $ABD\ index = 4.76 + 0.0003 (\text{number of lost teeth})^3$, when the mean values of age, PI, and ABL index 1970 were used (Table 1).

therefore refitted the model, replacing these variables with different transformations of them—the logarithm, the square root, the square, and the cube. The best result was obtained with the following equation:

$$ABD\ index = 4.109 + 0.00615 (V18)^2 - 0.055 (V2) + 0.0003 (V10)^3 + 0.78 (V17)$$

The coefficient of determination (R^2) was 0.43. The results of the analyses are illustrated graphically for ABL index 1970 and number of lost teeth (Figs. 1 and 2).

The curve in Fig. 1 represents the increase in ABD index when the mean values of age, PI, and number of lost teeth are used in the equation above. The curve in Fig. 2 represents the increase in ABD index when the mean values of age, PI, and ABL index 1970 are used in the equation.

Discussion

In the introduction it was mentioned that the material was unselected. The original material was reduced by death, emigration, and refusal to participate. Furthermore, edentate individuals and those with extensive dental restorations were excluded. However, it has been shown in a previous paper

(15) that it would be reasonable to suggest that the material still represents an unselected population.

During the 10-year period the subjects may have received a wide range of periodontal treatment. It has not been possible to record the intermittent course of destructive periodontitis or the differences between regions or sites. The dependent variable ABD index represents the individual mean value of the alveolar bone height difference in percentage of the root length after 10 years.

The purpose of the present investigation was to analyze factors influencing the progress of alveolar bone loss during a 10-year period, and such an approach is, otherwise expressed, an attempt to determine factors with a prognostic value. For that reason the predictors used in the analyses have been variables recorded in 1970. As far as we know, there exists no previous long-term longitudinal investigation of an unselected material focused on an analysis of factors influencing the progress of alveolar bone loss.

The original material was examined by multivariate analysis in 1970 (20). The ABL index 1970 was then the dependent variable. When we compared the results from the cross-sectional study in 1970 with those of

this longitudinal investigation, in which the ABD index is the dependent variable, age and number of lost teeth had strong correlation in both analyses. Calculus index and smoking were two of the predictors in the 1970 analysis which had p values <0.001 but did not attain significant correlation in the 1980 analysis. The reason is that the ABL index 1970 and the other strong predictors in the 1980 analysis have absorbed the effect of these two predictors.

Periodontal Index was recorded in 1970 but was then not used in the analysis because PI was supposed to be a measure of destructive periodontitis in the same way as the ABL index 1970. However, it was used in this investigation and reached significance level in spite of the presence of the ABL index 1970 in the analysis. This is interesting, since both of them are measures of periodontal status and since the correlation between them is strong. It might indicate that they are complementary predictors.

As was shown by Buckley & Crowley (21), 'a poorer prognosis was found for the teeth with destructive periodontal disease in the younger age group'. This is in agreement with the result in the present investigation, in which the stepwise multiple regression analyses give the predictor age a negative sign. This means that when we compared individuals with the same alveolar bone loss in 1970, the ABD index was higher in younger than in older individuals. The reason might be that the younger have a higher rate of bone loss than the older with the same ABL index 1970. Furthermore, teeth with very high ABL value in 1970 had been extracted because of destructive periodontitis during the 10-year period, and the remaining teeth therefore showed a relatively low ABD index in the older groups.

The coefficient of determination, R^2 , in Table 3 shows that 40% of the variance of the dependent variable, the ABD index, was explained by the four significant predictors. Even when all predictors were utilized for attaining a maximum R^2 , the increase was slight.

No predictors except for those in Table 3 reached even 20% significance level in the multiple regression analysis. Not only the

variables calculus index and smoking but also frequency of dental treatment, social class, partial dentures, and plaque index came into the 1970 analysis when the marginal bone loss index was the dependent variable, at least at the 5% significance level. They are, however, absent from the 1980 multiple regression analysis when the ABD index was the dependent variable. When the General Dental Health Insurance Act was introduced in 1973, the cost of dental care and preventive dentistry was significantly reduced, and preventive dentistry became more common. These facts may explain that social class did not reach significance level in 1980. The variables frequency of dental treatment, partial dentures, and plaque index have been absorbed by the four controlled significant predictors.

Of the 18 predictors used in the analyses the ABL index 1970 was the dominant one, with an R^2 value of 0.34. It seems to be an obvious conclusion that individuals with alveolar bone loss belong to a risk group with regard to higher rate of further bone loss. This is more apparent in the younger age groups. Another conclusion is that in spite of the use of as many as 17 predictors, all considered to influence the progress of alveolar bone loss over time, only 42% of the variance of the ABD index was explained.

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