A longitudinal investigation of the individual consistency of plaque levels in adults

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The present investigation was designed to determine the individual variation of plaque levels in adults over a period of 3 months. The participants were 20 healthy subjects, 11 men and 9 women, with a mean age of 42.3 ± 7.3(SD) years. Plaque area was determined with a computerized image analysis system and expressed as percentage of tooth area (P% Index). The scoring procedures were carried out three times (tests 1, 2, and 3) at an interval of 4 weeks. After each test all plaque was removed. All subjects were instructed to maintain their personal oral hygiene habits during the study. The results showed no significant differences for the means of P% Index between tests 1, 2, and 3 in the whole mouth, upper and lower jaws, right and left sides, or each tooth surface. The intraindividual plaque levels for individual tooth surfaces were closely correlated between tests 1, 2 and 3. The intraindividual plaque level was consistent in tests 1, 2, and 3 with standard deviations within subjects ranging from 1.1% to 6.2%. This study suggests that individual plaque levels seem to be consistent on the basis of tooth surface over a certain period of time. Individual plaque control should be more directed towards tooth surfaces with comparably high plaque accumulation within the mouth for significant reduction of the overall plaque levels. □ *Computerized planimetry; dental plaque; oral hygiene*

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Previous studies have shown a definite relationship between bacterial plaque on teeth and the inflammation and breakdown of the periodontal tissues (1–4). Efficient daily oral hygiene combined with regular professional cleaning seems to be an effective and reliable means of preventing plaque accumulation (5). Plaque control, mechanical and/or chemical, is the ideal and practical approach to prevent the initiation of gingivitis and to control periodontitis. The rate of plaque reaccumulation on cleaned tooth surfaces varies from person to person and even within the same dentition (6). However, the longitudinal consistency of plaque levels on an individual and a tooth-surface basis has not been thoroughly clarified.

The objective of this study was to determine the individual variation of plaque levels in adults over a period of 3 months, using a method yielding a quantitative measurement of the plaque areas.

Materials and methods

The subjects studied were 20 adults, 11 men and 9 women, with a mean age of 42.3 ± 7.3 years (range, 35–49 years) with good general health and periodontal status. All subjects had been enrolled in a professional dental care system, including routine prophylaxis, for the past 5 years. None had received periodontal prophylaxis or antibiotics during the previous 3 months. They were requested to maintain their personal oral hygiene habits during the study.

The subjects were examined clinically, and plaque was disclosed with erythrosin on all tooth surfaces excluding the third molars. The teeth were photographed with a Nikkormat camera (FT2, Nippon, Kogaku, K.K., Japan) with a Micro Nikkor lens (55 mm, 1:35, Soligor MC, Auto Tele Converter, Nippon), flash, and Kodak film (Ektachrome 100 HC, Eastman Kodak Co.), perpendicular to the tooth surfaces on the buccal and lingual/palatal sides. The lingual and palatal sides of anterior and all posterior sections were photographed with mirrors for oral photography (Skandinavisk, Dentalfoto AB, Lidhult, Sweden). Twelve photographs were taken at each session for each subject.

The procedure was carried out three times at a fixed time of day at 1-month intervals (tests 1, 2, and 3). One month before the study started and after each test the plaque present on all tooth surfaces was removed by supragingival scaling and polishing by the same investigator (B. Söder), providing a zero base line of plaque levels for each test.

All the photographs were analyzed by means of an established computerized image analysis system (CIAS) (7, 8). The color slides were enlarged 10-fold, and the images of tooth area and plaque area on the photographs were analyzed and counted directly in pixels by the CIAS. The plaque area was then calculated in per-

centage of tooth area (plaque percentage index (P% Index)). All the photographs from each occasion (tests 1–3) were scored at the same time in a random order by the same examiner. The repeatability of the photographic assessment had been determined in a previous study, with an intraexaminer variation of 0.28% and intraexaminer correlation coefficient of 0.99 (8). In all, 3360 tooth surfaces were analyzed.

The paired *t* test was used to analyze the difference of means between tests 1, 2, and 3 and to compare the plaque levels on individual tooth surfaces over the 3-month period. The intraindividual variation of plaque levels in tests 1–3 was presented for each subject, including standard deviation (SD) and range. The correlation of the plaque level on individual tooth surfaces between two tests was determined with linear correlation analysis, and the values of correlation coefficient (*r*) were presented.

Results

No differences were found ($p > 0.05$) for all 20 subjects among tests 1–3 for the mean P% Index of the whole mouth or specific tooth surfaces and sections, including buccal and lingual tooth surfaces, upper and lower jaws, and right and left tooth sides.

For individual tooth surfaces no significant differences in plaque levels ($p > 0.05$) were found for all tooth surfaces among tests 1, 2, and 3, except for buccal surfaces on lower left second molars between tests 1 and 3. There was marked variation in mean plaque levels between different tooth surfaces.

Intraindividual correlation coefficients (*r*) for individual tooth surface scores of P% Index values among tests 1, 2, and 3 were determined, respectively. Between tests 1 and 2, 84% (16 of 19) of the subjects had a strongly positive ($p < 0.01$) correlation, with an *r* value ≥ 0.5 (0.5–0.8), and 11% (2 of 19) had a positive ($p < 0.05$) correlation with *r* values of 0.3 and 0.4, respectively. Between tests 2 and 3, 94% (17 of 18) of the subjects had a strongly positive ($p < 0.001$) correlation, with an *r* value ranging from 0.5 to 0.7. Between tests 1 and 3, 58% (11 of 19) of the subjects had a strongly positive ($p < 0.001$) correlation, with an *r* value ≥ 0.5 (0.5–0.8), and 32% (6 of 19) had a positive ($p < 0.05$) correlation, with an *r* value ≥ 0.4 (0.4–0.6). When all three sets of tests 1–3 are included, 83% of the subjects (15 of 18) had highly significant ($p < 0.01$) correlation between the respective sessions. At tests 2 and 3, data were missing from one subject.

Table 1 shows the overall mean P% Index values for the three occasions (tests 1–3) and the intraindividual standard deviation and minimal and maximal values that were registered at one of the three occasions for each subject. The individual overall mean values of the three occasions ranged from P% Index 6.5 to 35.6. The intraindividual standard deviation (SD) of P% Index ranged from 1.1 to 6.2.

Table 1. Overall means and standard deviations (SD) of the plaque percentage index of values on the three occasions (tests 1–3) and the minimal and maximal mean values that were registered on one of the three occasions for each subject

Subject	Mean	SD	Minimal	Maximal
1	16.4	3.5	14.3	20.4
2	24.1	2.2	22.1	26.4
3	30.4	5.2	25.5	35.8
4	12.1	1.5	10.8	13.7
5	16.3	6.2	11.5	23.3
6	11.4	3.9	8.6	14.1
7	13.7	3.7	11.0	17.9
8	13.9	2.0	11.5	16.0
9	29.2	4.2	26.2	32.1
10	25.8	1.8	23.7	27.2
11	17.0	2.1	15.1	19.3
12	35.6	4.1	33.0	40.4
13	11.2	3.3	7.4	13.5
14	6.5	1.1	5.2	7.3
15	18.5	2.0	17.0	20.8
16	7.0	2.0	4.9	8.8
17	7.7	2.1	5.5	9.8
18	30.9	2.1	28.5	32.4
19	12.7	1.4	11.6	14.2
20	11.3	5.2	5.5	15.2

Discussion

Many methods are available for estimating plaque accumulations on tooth surfaces (9, 10). Most are based on scoring of plaque area on an ordinal scale (11–13). These indices are subject to the sensitivity of the examiner and rely on an individual interpretation of plaque area on tooth surfaces (14). The present computerized planimetric method yields a quantitative measurement of plaque area on an interval scale and is convenient for clinical measurement of plaque area, with a high degree of reproducibility and discriminative power in detection of minor changes on individual tooth surfaces (8). It can be used for longitudinal study of quantitative changes in plaque level. In addition, for statistical analysis in general, the use of an interval scale is preferred (15). The application of parametric statistics to ordinal data has been widely criticized (16).

In the present study all subjects had participated in a regular oral care system and received professional prophylaxis for 5 years. During the period of the present investigation the participants received no special oral hygiene instructions and were requested to maintain their routine oral habits. The P% Index values on test 1 represent the individual base-line plaque levels. The results showed no significant difference for the mean of all tooth surfaces, the buccal and lingual surfaces in the upper and lower jaws, and the right and left tooth sides among tests 1, 2, and 3. On the basis of individual tooth surfaces almost every surface maintained its base-line plaque levels over the period of 3 months, although

there were great variations among the different tooth surfaces within the subjects.

At the individual level a strongly positive correlation was found in 95% of the subjects between tests 1 and 2 in 94% between tests 2 and 3, and in 90% between tests 1 and 3, with correlation coefficient values (r) ranging from 0.3 to 0.8. This suggests that the pattern of individual plaque levels is rather consistent over time. The intraindividual variation of plaque levels was overall low during the 3-month period, with standard deviations (SD) in P% Index from 1.1 to 6.2 (Table 1). These results show that intraindividual plaque levels seem to be fairly consistent over time with low variation, although the interindividual levels of plaque varied widely at base line. The interindividual plaque level may mainly be related to variations in personal oral hygiene habits and specific oral conditions. The intraindividual plaque level and characteristics of plaque distribution, however, seemed to be constant over a given period of time when oral hygiene routines and personal habits were maintained. It is, therefore, suggested that for individuals to improve oral hygiene, a special regimen for plaque control or new oral hygiene aids directed to specific tooth surfaces is necessary (17).

This study suggests that individual plaque levels seem to be consistent on the basis of tooth surfaces over a certain period of time. Individual plaque control should be directed more towards those tooth surfaces where comparably high plaque accumulated within the mouth for significant reduction of the overall plaque levels.

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