

The Natural History of Periodontal Disease in Man

The Rate of Periodontal Destruction Before 40 Years of Age*

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MOST CROSS-SECTIONAL data suggest that periodontal disease is universal: that it starts early in life and increases in severity with age.¹⁻⁵ However, since no longitudinal studies on the life-time characteristics of periodontal disease have been made, it is not known to what extent the progress of the lesion is continuous or if the disease is characterized by intermittent periods of activity and inactivity in people of different ages and around specific teeth. Also the cross-sectional studies have failed to provide accurate accounts of the rate with which the lesion progresses during different age periods of human life. This paper attempts to address these problems.

The present study was part of a longitudinal investigation, the purpose of which was to describe the natural development and progress of periodontal disease in man. The study started in Oslo, Norway in 1969 and in Sri Lanka in 1970. The two population groups subject to the study were chosen in anticipation of big differences in the rate of periodontal destruction. Indeed, the baseline data indicate that this was the case.⁶ The two groups also show geographical, cultural, socio-economic and educational differences and they represent extremes both as to general health care delivery systems and to dental care. Therefore, the primary objectives of the study was to establish a set of baselines against which populations with similar or different characteristics may be compared, and great caution should be exercised in comparing directly the various disease parameters in these groups in order to explain the differences.

For detailed information on study design, demography and base line data, see Löe et al. 1978a.⁶ The purpose of this report was to describe the frequency, pattern and rate of the loss of periodontal support from adolescence to approximately 40 years of age.

MATERIALS AND METHODS

The first group was established in Oslo, Norway in 1969 and consisted of 565 healthy male, nondental students and academicians between 17 and 30+ years of age (Table 1). The older age groups (born between 1934 and 1939, in 1940, 1942, 1944, 1946 and 1948) were drawn from the census filed with the Central Bureau of Statistics and the younger age groups (born in 1950 and in 1952) were recruited from three high schools in Oslo selected by the City Board of Education. The principal reasons for selecting Oslo as a study site was that this city had a preschool, school and postschool dental program offering systematic preventive, restorative, endodontic, orthodontic and surgical therapy on an annual recall basis for all children and adolescents (3-16 years of age) with a documented attendance record of 90% for the last 40 years. It is also a matter of record that the remaining 10% make use of the personal services provided by the private practitioners in the area. In addition, the city of Oslo offers a reimbursement plan for expenses incurred for dental services from the period between graduating from high school to 21 years of age, and the University through its Student Health Services provides a dental care program for students; therefore, it is fair to state that the chosen population represents a group of individuals that has had maximum exposure to conventional dental care throughout its life.

A second group was established in Sri Lanka in 1970 and consisted of 480 male tea laborers between 15 and 30+ years of age. The participants were all Tamils and descendants of groups who two to three generations ago emigrated from southern India. They were healthy and well-built by local standards and their nutritional condition was clinically fair. The workers had never been exposed to any programs or incidents relative to prevention or treatment of dental diseases. Toothbrushing was unknown.

The Norwegian group was first examined in 1969. Subsequent examinations took place in 1971, 1973, and 1975. The next examinations are scheduled for 1979, 1983 and 1987. The Sri Lanka group was examined initially in 1970 and in 1971, 1973 and 1977. The next examinations are scheduled for 1981, 1985 and 1989. The time span between the first and fourth examinations was in Oslo 6 years and 3 months, and in Sri Lanka 7 years and 6 months.

At each appointment the participants answered questions regarding personal dental care and habits, the oral cavity at large was inspected and missing teeth were recorded at each appointment. The clinical examination of the periodontal tissues and adjacent portions of the dentition included measurements and scoring of various indices⁶ on all mesial and facial (buccal) surfaces of all teeth except third molars. All examinations throughout the study were performed by the same two examiners who were both well-trained and experienced periodontists. One always scored the periodontal situation (gin-

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TABLE 1. Number of Norwegian Students and Academicians That Participated in Each Survey and the Number That Participated in all Surveys by Birth Cohort 1969–1975

Year of birth	1969	1971	1973	1975	In all surveys
1934–39	40	23	15	14	9
1940	38	28	21	18	13
1942	76	46	37	31	22
1944	96	62	43	42	26
1946	94	66	54	49	37
1948	78	58	50	40	26
1950	62	33	33	20	13
1952	81	65	39	31	21
Total	565	381	292	245	167

gival index and loss of attachment). The other always scored for local exogenous factors (plaque, calculus, gingival caries and fillings). Each participant having all his teeth, with the exception of the third molars, was scored for 6 indices at two sites per tooth, totalling in the case of a complete dentition 336 recordings for each individual at each examination.

The sequences of scoring were always the same: plaque, calculus, fillings, and caries were first assessed in that order by investigator A using a pointed probe. The participant would then move over to another chair where investigator B would score for gingivitis and measure loss of attachment. Loss of attachment was measured with a blunt probe with a point diameter of 0.6 mm and graded at 1, 2, 3, 4, 5, 7, 9, and 11 mm. The same probes were used at all examinations in Norway and Sri Lanka. Special efforts were made to maintain measuring force between 20 to 30 gm throughout the study. All scores were dictated to the chairside assistant who recorded the scores on special scoring cards.

The examinations of the Norwegians took place at a modern, well equipped clinical facility provided by the Oslo University Faculty of Dentistry. The Sri Lankans were examined in an outdoor facility comprising portable dental chairs and adequate supporting equipment except compressed air and saliva ejectors.

No preventive or therapeutic measures were undertaken during the examinations. Actually, since the purpose of this investigation was to study the natural development of periodontal disease, the investigators made special efforts to avoid any disruption of habits, home care practices or any other activity pertaining to the oral health status of the participants in Norway as well as in Sri Lanka. (For further details on materials and methods used in the study see Løe et al. 1978⁶).

Data Analysis

As with most studies of this size, a certain number of the population dropped out and could not be followed up. Tables 1 and 2 show the number of individuals who participated in each survey by birth cohort. In both populations loss to follow-up individuals appears to be independent of age.

In the analysis of the development of periodontal disease, two groups were of interest—those who were present in all surveys (I.A.S.) and those who appeared in at least one survey, the all valid observation group (A.V.O.). The I.A.S. group was compared to the total A.V.O. group on loss of attachment to determine if those who failed to follow-up were significantly different from those who remained in the study. The A.V.O. group was useful for estimating certain population parameters while the I.A.S. group was useful in following the individual surface changes through time.

In order to get a complete picture of the development of the disease from the youngest age group to the oldest age group observed, cross-sectional means were calculated. They are weighted averages of each age group as the birth cohort moves longitudinally through the age group. This development of the disease is traced from

TABLE 2. Number of Sri Lankan tea Laborers That Participated in Each Survey and the Number That Participated in all Surveys by Birth Cohort 1970–1977

Year of birth	1970	1971	1973	1977	In all surveys
1940	35	31	27	19	16
1942	36	32	27	19	18
1944	61	52	46	30	22
1946	54	51	43	27	25
1948	77	65	58	32	28
1950	62	54	51	27	24
1952	69	63	54	33	28
1954	47	40	35	22	18
1956	40	34	29	19	17
Total	480	422	370	228	196

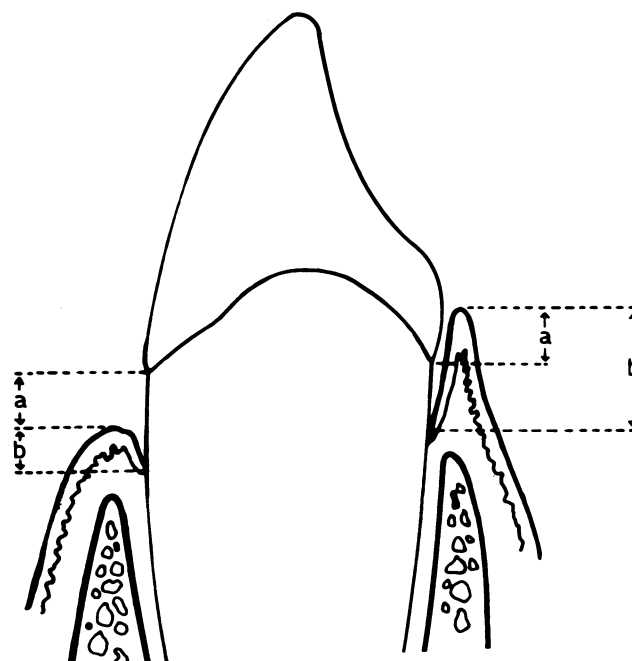


FIGURE 1. Diagram showing the units of measurement when loss of attachment is followed by pocket formation (right) and with gingival recession (left).

age 15 to 37+ in Sri Lanka and from 17 to 37+ in the Oslo group.

Method Errors

Loss of attachment refers to the detachment of connective tissue fibers originally anchored in the root cementum and the proliferation of pocket epithelium below the cemento-enamel junction, or in case of recession of the gingiva, the denudation of the root surface. For all practical purposes the process including the loss of fiber attachment is irreversible. Clinically and quantitatively, loss of attachment is the distance from the cemento-enamel junction (CEJ) to the bottom of the clinical pocket. When the CEJ is located apical to the gingival margin (Fig. 1, right) loss of attachment (LA) is calculated as the difference between the depth of the pocket (a) and the distance (b) from the gingival margin to the CEJ: $a - b = LA$ (Fig. 1).

In cases where the marginal gingiva has been subject to recession (Fig. 1 left) and the CEJ is exposed, the loss of attachment equals the sum of pocket depth and the distance from the gingival margin to the CEJ: $a + b = LA$.

Marginal extensions of fillings and other dental restorations as well as carious lesions and other hard tissue defects sometimes complicate the assessment and even render the recognition of the cemento-enamel junction impossible. Out of a total of 79,653 surfaces examined during the four examinations in Sri Lanka, only 892 (1%) could not be measured for loss of attachment. The comparable figures for Norway were 78,752 and 1788 (2%).

Previous investigations in a population between 20 and 40 years⁷ of age have shown that the method error for single measurement of loss of attachment was less than ± 0.5 mm, indicating that loss of attachment may be measured to the nearest millimeter. The error of the means for each person was ± 0.12 mm. However, additional data indicate that variation in measurement is predicated on the degree of health and disease of the periodontium.⁸

Intra-examiner reproducibility for the loss of attachment index was tested at baseline and repeated periodically throughout the study. In the Norwegian group, 29 students were scored twice during the first session in 1969. The individuals were selected for reexamination at random by the secretary of the project. Usually the participants were requested to report back the next day, but due to various circumstances, some were scored the same day. Every effort was made to keep the examiners blind at the second scoring. In Sri Lanka, 35 tea laborers were selected at random in 1970 and reexamined once according to the protocol used in Oslo in 1969.

The actual assessment of reproducibility was accomplished using the reproducibility matrix.⁹ A matrix was produced for the loss of attachment index by surface type (buccal or mesial) and tooth type (incisor, bicuspid or molar). The reproducibility matrix describes all the surface calls at each scoring and the movements between scorings. It also gives an estimate of the probability of moving from category to category and the standard error. Overall percentage of agreement is calculated by adding the diagonal elements of the matrix (Tables 3 and 4) and dividing by the total number of calls. In addition the *t* test was used to test for difference between the mean

TABLE 3. *Reproducibility Matrix of Loss of Attachment for 35 Male Sri Lankans Describing Number of Cells, Transition Probability and Standard Error*

Time 1 ↓	Time 2					Total row
	0	1	2	3	Other	
0	911 0.82 (0.012)	171 0.15 (0.011)	17 0.02 (0.004)	5	3	1107 0.56 (0.011)
1	126 0.30 (0.022)	229 0.54 (0.024)	57 0.13 (0.016)	9 0.02 (0.007)	4 0.01 (0.005)	425 0.22 (0.009)
2	10 0.06 (0.019)	52 0.34 (0.038)	55 0.36 (0.039)	27 0.18 (0.031)	10 0.06 (0.019)	154 0.08 (0.006)
3	4 0.05 (0.021)	15 0.19 (0.044)	18 0.22 (0.046)	28 0.35 (0.053)	16 0.20 (0.044)	81 0.04 (0.004)
Other	9 0.05 (0.016)	3 0.01 (0.007)	8 0.04 (0.014)	13 0.07 (0.018)	160 0.83 (0.027)	193 0.10 (0.007)
Total column	1060 0.54 (0.011)	470 0.24 (0.010)	155 0.08 (0.006)	82 0.04 (0.004)	193 0.10 (0.007)	1960 % Agreement = $\sqrt{70.6}$

scores at time 1 and time 2 and Chi-Square tests were used to detect distributional differences.

Condensed versions of the overall reproducibility matrix are shown in Tables 3 and 4. The Sri Lankan group (Table 3) had an overall percentage of agreement of 71% and ranged from a low of 58% for the mesial surfaces of molars to 74% for the buccal surfaces of incisors. The corresponding rate for the Norwegians (Table 4) was 72% overall and 64% for the mesial surfaces of molars and 79% for the buccal surfaces of incisors. Both groups exhibited the same pattern of agreement with improved agreement scores as one move toward the center of the dentition. In general, the buccal surfaces showed higher reproducibility than the mesial surfaces for each tooth type in both groups.

All *t* tests and Chi-Square tests showed no significant differences ($P < 0.1$) between the mean scores or distribution of the scores in the two scorings. This was true for all surfaces and tooth types.

For the Sri Lankan group, the overall percent of agreement was 71% (Table 3), and the agreement between measurements within 1 mm was over 95%. In order to simplify the tables, the other category includes all scores greater than 3 mm as well as surfaces not included. In Sri Lanka, for example, there were 160 surfaces which were excluded, and only 33 with scores greater than 3 mm. Zero proved to be the most stable score with 82% of the surfaces scored, zero at time 1 remaining zero at time 2. In general, this declined as the magnitude of the scores increased. The calls in the Norwegian group (Table 4) were generally more consistent with 98% of the cells within 1 mm of each other.

Most of this increase in agreement was due to no decline in consistency beyond the 1 mm score.

The results indicate that no systematic bias was shown by the examiner and that the scores were highly consistent within each survey.

It is difficult to eliminate or even detect changes in criteria within examiners from year to year. However, some check on this type of method error is possible. Analogous to the caries reversal rate, one can examine the reversal experience of the loss of attachment index. Like caries, the reversal rate of loss of attachment should be small in order to conform to existing theory. Throughout the study, the scores for loss of attachment on individual surfaces remained relatively constant in increase, decrease and stability (Tables 5 and 6). The highest rate of 15% reversal occurred in the Sri Lanka group from Survey 1 (1970) to Survey 2 (1971). However, all but 3% represented a reversal of only 1 mm and were within the range of acceptable measurement error. Tables 5 and 6 give a good indication that the examiner remained consistent during the course of the study.

RESULTS

The Norwegian Group

The baseline examination in 1969 revealed that approximately half of the group of 17-year-old Norwegian students (born in 1952) had experienced no loss of periodontal attachment. An additional 40% exhibited maximum score at 1 mm. Mean loss of attachment for the group was 0.06 mm (SD = 0.24). At this age, 99% of all root surfaces measured 0 or 1 mm loss of attachment;

TABLE 4. *Reproducibility Matrix of Loss of Attachment for 29 Male Norwegians Describing Number of Cells, Transition Probability and Standard Error*

Time 1 ↓	Time 2					Total row
	0	1	2	3	Other	
0	760 0.79 (0.013)	194 0.20 (0.013)	5 0.01 (0.003)	1	2	962 0.59 (0.012)
1	144 0.32 (0.022)	262 0.58 (0.023)	37 0.08 (0.013)	5 0.01 (0.005)	5 0.01 (0.005)	453 0.28 (0.011)
2	7 0.08 (0.028)	18 0.20 (0.042)	57 0.62 (0.051)	9 0.10 (0.031)	1 0.01 (0.010)	92 0.06 (0.006)
3	0	0	9 0.38 (0.099)	13 0.54 (0.102)	2 0.08 (0.055)	24 0.01 (0.002)
Other	6 0.06 (0.025)	3 0.03 (0.018)	2 0.02 (0.015)	0	82 0.88 (0.034)	93 0.06 (0.006)
Total column	917 0.56 (0.012)	477 0.29 (0.011)	110 0.07 (0.006)	28 0.02 (0.003)	92 0.06 (0.006)	1624 % Agreement = $\sqrt{72\%}$

TABLE 5. Number and Percent Increases and Decreases (Reversals) as Related to Measurement of Periodontal Loss of Attachment in 196 Sri Lankans Who Participated in All Surveys 1970-1977

	Survey 1	Survey 2	Survey 3	Survey 4
Increase in LA	2868 (29%)	6803 (66%)	8981 (88%)	
Same LA	5578 (56%)	3031 (29%)	977 (10%)	
Decrease in LA	1502 (15%)	475 (3%)	193 (2%)	
(% with 1 mm)	(12%)	(4%)	(1%)	
Total	9948	10309	10153	

TABLE 6. Number and Percent Increases and Decreases (Reversal) as Related to Measurement of Periodontal Loss of Attachment in 167 Norwegians Who Participated in All Surveys 1969-1975

	Survey 1	Survey 2	Survey 3	Survey 4
Increase in LA	1596 (16%)	4806 (46%)	4711 (54%)	
Same LA	6037 (68%)	4125 (47%)	3540 (40%)	
Decrease in LA	1194 (14%)	588 (7%)	531 (6%)	
(% within 1 mm)	(12%)	(6%)	(5%)	
Total	8827	8799	8782	

only 0.6% measured between 2 and 4 mm (Table 7). No single measurement over 3 mm was recorded. Loss of attachment when present occurred mainly on the buccal surfaces of maxillary and mandibular first bicuspid and first molars.

Among 19-year-olds there were still 30% who showed no loss of periodontal attachment. As seen in Figure 2, with increasing age more teeth showed loss of attachment. In the 31-year-old Norwegian academicians the mean loss of attachment was still only 0.98 mm (SD = 1.07) and more than 73% of the root surfaces measured 0 or 1 mm loss of attachment (Table 7). The maximum loss of attachment for any surface recorded in this age group was 5 mm.

The participants who were 17, 19, 21, ... 30+ years of age in 1969 and appeared at some or all reexaminations over the subsequent 6 years (Tables 8 and 9) showed a very slow mean increase in loss of attachment during the early twenties. Each age cohort increased its loss of attachment over the 6 years from 1969 and 1975 with approximately 0.5 mm (range 0.34-0.78, Table 8). When only those who participated in all four surveys (Table 9) were considered, this rate of progression did not change. There was a constant, almost linear increase in mean loss of attachment with age for both buccal and mesial surfaces of the various teeth in both jaws (Figs. 3 and 4). This linear increase in mean loss of attachment was found in those who participated in some of the surveys and in those who appeared in all (Fig. 5).

At age 37+ years the mean loss of attachment was 1.66 mm (SD = 1.00), 46.5% of the root surfaces still measured 0 or 1 mm loss of attachment and 46% measured between 2 and 4 mm (Table 7). Only four surfaces out of 750 recorded in this age group measured 5 mm or more. The mean annual rate of attachment loss for

different teeth in both jaws varied between 0.07 and 0.13 mm.

For mesial surfaces the mean annual rate of attachment loss during the various age periods varied between 0.05 and 0.10 (Table 10). The buccal surfaces generally showed slightly higher rates (0.08-0.14 mm per year). This was particularly true for bicuspid (No. 4, 5) and molars (No. 6, 7) of both jaws. In anterior teeth (No. 3, 2, 1) either no such differences could be found or the mesial surfaces tended to show a slightly greater rate of attachment loss. The rate of periodontal destruction did not increase significantly with age. No significant systematic differences were found between the right and left sides of the respective jaws.

The Sri Lanka Group

Approximately 20% of the 15-year-old Sri Lankans (born in 1956) showed no loss of periodontal attachment. An additional 50% of this group showed maximum score of 1 mm. Approximately 96% of the total number of tooth surfaces measured 0 or 1 mm loss of attachment (Table 7). The mean loss of attachment for the group was 0.17 mm (SD = 0.57). However, approximately 30% of 15-year olds showed one or more lesions measuring between 2 and 9 mm, and 1% of this age group exhibited one or more lesions measuring attachment loss of 10 mm or more. When loss of attachment occurred, it was most often confined to mandibular central incisors (No. 1) and first molars (No. 6) of both jaws (Fig. 6).

At 17 years of age less than 9% of the group exhibited quantitatively normal periodontal support and at 19 the frequency of persons with no loss of attachment had dropped to approximately 3.5%. Above the age of 21 years all participants showed loss of attachment of various degrees. The 31-year-old Sri Lankan tea laborer showed a mean loss of 3.11 mm (SD = 2.58) (Table 7). At this age only 30% of all measurements were below 2 mm and 65% of the surfaces measured losses between 2 and 9 mm. In more than 26% of the 31-year olds, one or

TABLE 7. Frequency and Degree of Attachment Loss (LA) in Mesial and Buccal Root Surfaces in Norwegian Students and Academicians (N) and Sri Lankan Tea Laborers (SL) Between 15 and 37+ Years of Age

Age	Mean LA mm		Percent measurements of attachment loss							
	N	SL	0-1 mm		2-4 mm		5-9 mm		10 mm	
	N	SL	N	SL	N	SL	N	SL	N	SL
15		0.17		96.39		1.80		0.24		0.04
17	0.06	0.23	99.03	95.51	0.59	3.26	0	0.16	0	0.00
19	0.15	0.40	97.42	91.62	2.22	6.71	0	0.56	0	0.00
21	0.41	0.68	90.74	85.28	7.43	12.74	0.09	1.04	0	0.06
23	0.52	0.92	89.89	78.73	8.84	17.71	0.21	2.46	0	0.09
25	0.66	1.14	85.24	74.01	12.12	20.25	0.31	4.21	0	0.24
27	0.74	1.23	79.96	67.68	15.31	29.26	0.54	2.37	0	0.06
29	0.78	2.06	79.44	50.78	16.80	33.09	0.25	12.16	0	1.03
31	0.98	3.11	73.27	30.67	20.33	43.67	0.94	21.14	0	2.93
33	1.14	3.44	66.86	21.95	27.80	49.08	1.21	25.35	0	2.20
35	1.36	3.88	57.56	12.69	35.23	50.09	0.47	33.49	0	2.34
37+	1.66	4.50	46.53	6.16	48.13	49.70	0.54	36.55	0	5.54

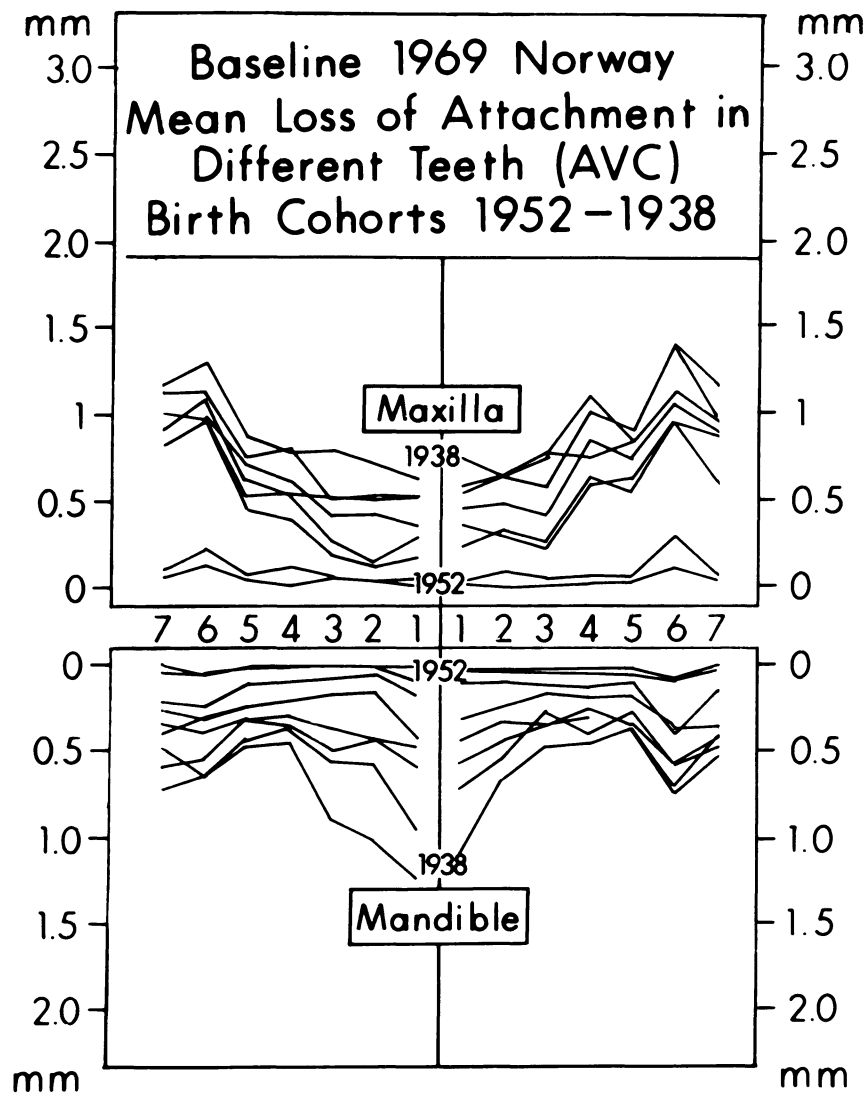


FIGURE 2. Mean loss of attachment in different teeth of Norwegian students and academicians aged between 1 and 30+ years.

TABLE 8. Mean Loss of Attachment on Interproximal Surfaces in Norwegian Students and Academicians That Participated in All Valid Observations Groups 1969-1975

Age	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36	37 +				
Year															
1969	.02 81	.07 62	.33 78	.41 94	.53 96	.66 76	.63 38	.86 40	/						
1971	/		.15 64	.28 32	.22 58	.27 66	.37 61	.35 46				.66 28	.95 23		
1973			.49 39	.66 33	.67 49	.72 53	.91 43	.92 36				1.12 21	1.20 16		
1975	/		/		.61 31	.71 20	.75 40	.72 49				.92 42	.98 31	1.18 18	1.41 14
Cross-sectional means					.02 81	.11 126	.36 149	.43 216				.50 231	.61 230	.65 176	.85 146

more surfaces measured loss of attachment of 10 mm or above.

The baseline data from 1970 (Fig. 6) as well as the cross-sectional means for the cumulative material (Table 11) showed that with age there was a significant increase

in loss of attachment and involvement of more teeth.

When only those who participated in all surveys were considered (Table 12) it is seen that almost identical increases had taken place.

At the age of 37+ years the mean loss of attachment

TABLE 9. Mean Loss of Attachment on Interproximal Surfaces in Norwegian Students and Academicians That Participated in All Four Surveys 1969-1975

Age	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36	37+				
69	.02 21	.05 13	.38 26	.38 37	.44 26	.51 22	.69 13	.58 9							
71			.12 21	.24 13	.21 26	.24 37	.33 26	.34 22				.70 13	.88 9		
73					.51 21	.68 13	.69 26	.70 37				.87 26	.89 22	1.19 13	1.10 9
75							.61 21	.70 13				.75 26	.72 37	.90 26	.97 22
Cross-sectional means	.02 21	.09 34	.40 60	.42 97	.46 102	.59 111	.67 98	.82 70	1.02 44	1.17 22	1.36 9				

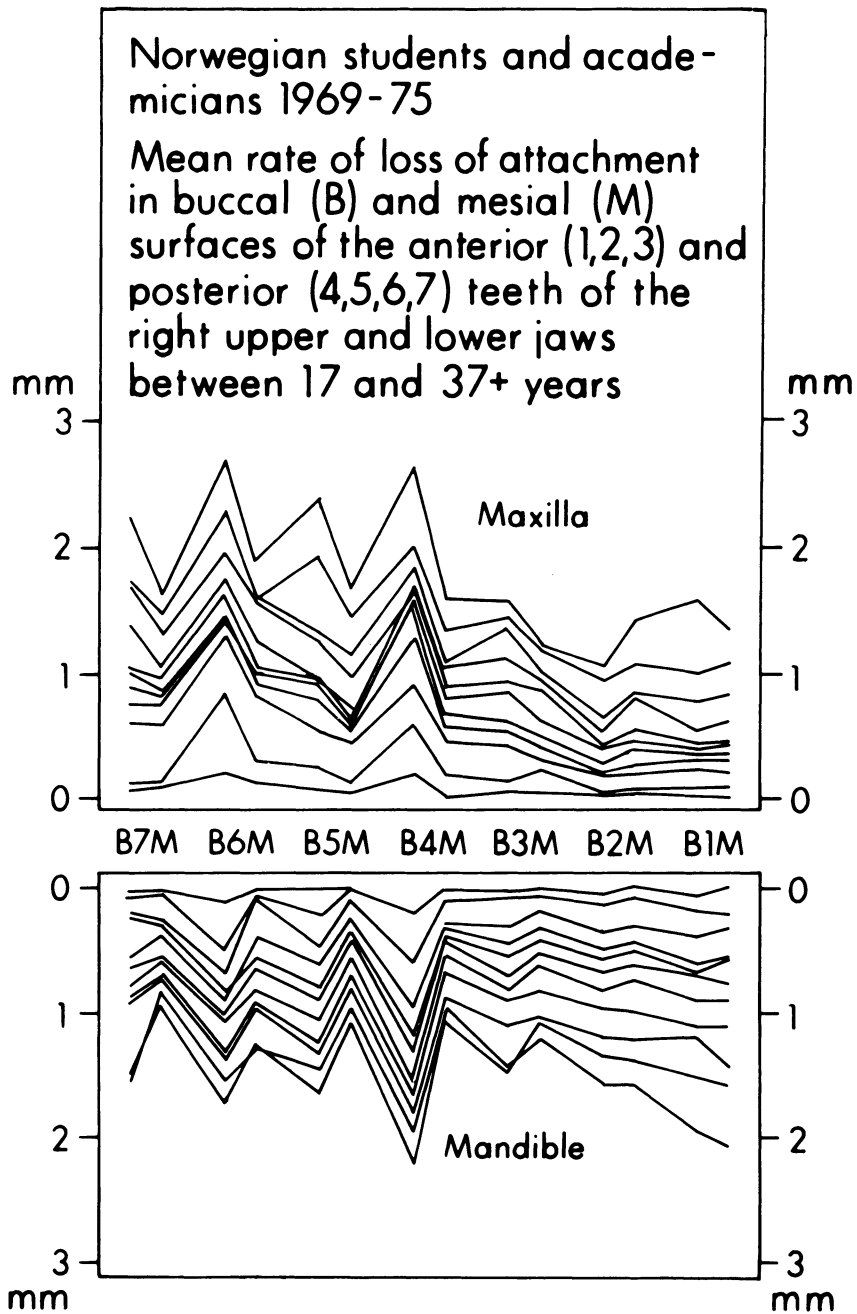


FIGURE 3. Mean rate of attachment loss in buccal (B) and mesial (M) root surfaces of anterior (1, 2, 3) and posterior (4, 5, 6, 7) teeth of Norwegian students and academicians between 17 and 37+ years.

Mean loss of attachment (LA) in mesial (●—●) and buccal (x—x) root surfaces in Norwegian students and academicians (—) and Sri Lankan tea laborers (—) according to age (IAS).

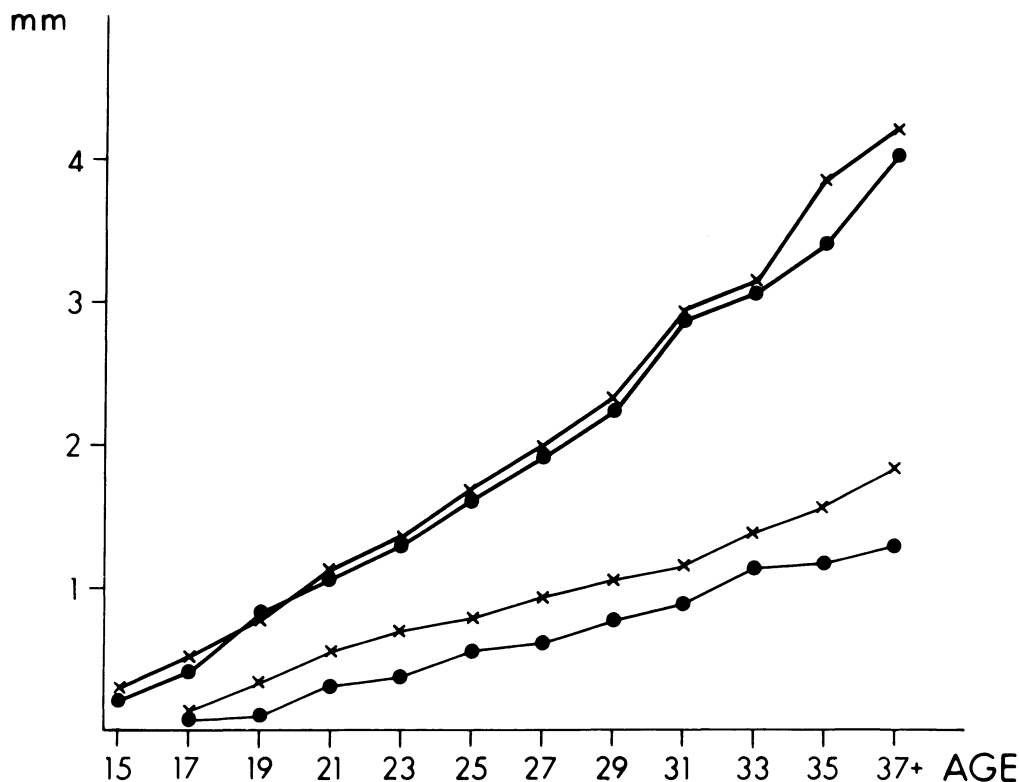


FIGURE 4. Mean loss of attachment in mesial (●—●) and buccal (x—x) root surfaces in Norwegian students and academicians (—) and Sri Lankan tea laborers (—) according to age.

was 4.50 mm (SD = 2.60) (Table 7); only 6% of the tooth surfaces now measured 0 or 1 mm loss; approximately 50% measured between 2 and 4 mm and 36% had loss of attachment between 5 and 9 mm. More than 5% of the recorded surfaces measured 10 mm or more.

Figure 7 shows that there was a continuous increase in the loss of attachment with age for buccal and mesial surfaces of all teeth. The mean rate of attachment loss for the different teeth of both jaws varied between 0.20 and 0.24 mm per year. The mean annual rates for mesial surfaces during successive age periods varied between 0.18 and 0.29 mm (Table 10). The rates for buccal surfaces were slightly lower (0.18–0.25 mm per year). The rate of destruction of the periodontium showed a significant increase during the late twenties and throughout the thirties, with loss of attachment approaching 0.3 mm per year. No systematic differences were found between teeth on the right and left sides of the jaws.

DISCUSSION

This study of a random selection of Norwegian students has shown that approximately 50% of the 17-year

olds have lost no periodontal support and that the other 50% show slight loss of attachment in localized areas of the dentition. At or before 17 years of age these lesions occur on the buccal aspects of maxillary and mandibular first bicuspid and first molars. Before the age of 20 there is no general loss of attachment, although individual teeth may measure loss of attachment up to 3 mm. As they pass 20 years of age, all students exhibit one or more root surfaces with attachment loss, the buccal surfaces that had lesions prior to this age, continue to show a slow increase in loss of attachment, more teeth become involved and the interproximal surfaces are affected. This pattern of development is maintained throughout the twenties at a rate of approximately 0.05 mm per year for mesial surfaces and approximately 0.1 mm for buccal surfaces. By the time the individual has reached 30 years of age, the mean cumulative loss of attachment is still less than 1 mm. During the thirties the buccal surfaces generally continue to show greater loss of attachment than interproximal surfaces, especially in bicuspid and molars of both jaws. In anterior teeth this pattern is less conspicuous.

Mean loss of attachment (LA) on mesial root surfaces in Norway and Sri Lanka, based on all valid observations (AVC) (—) and on participation in all surveys (IAS) (xxx).

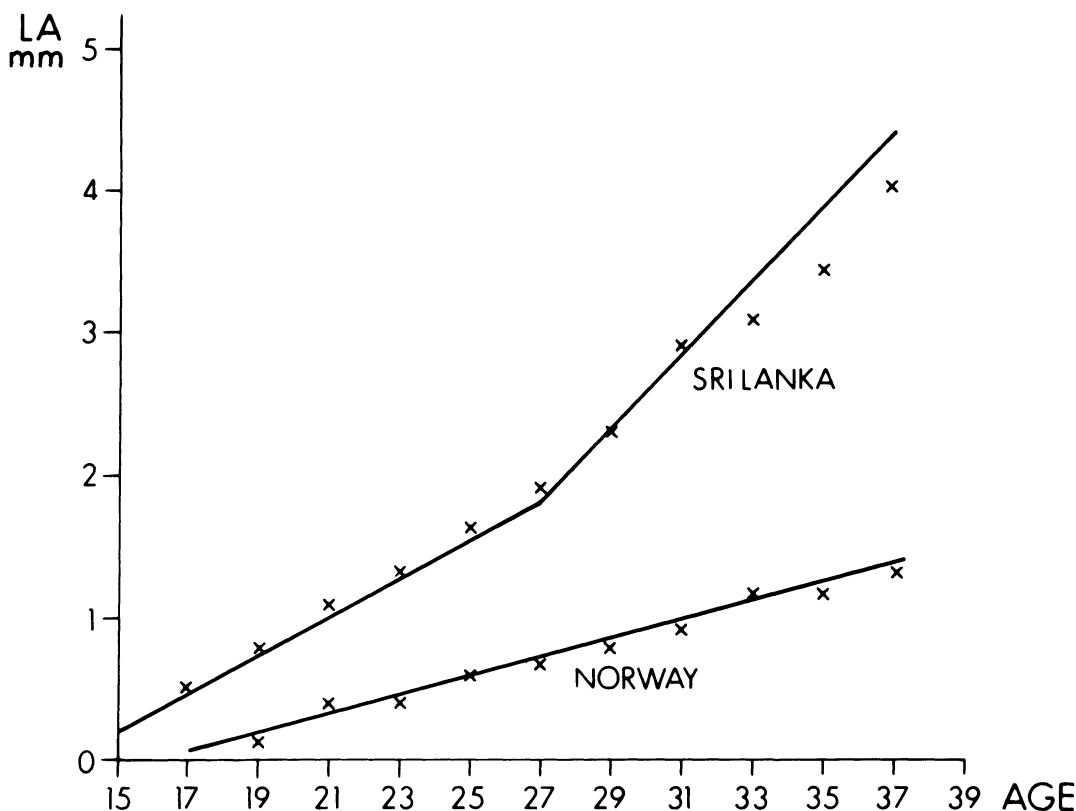


FIGURE 5. Mean loss of attachment on mesial root surfaces in Norway and Sri Lanka in those who participated in some (—) and in those who appeared in all surveys (xxx).

TABLE 10. Annual Rate of Attachment Loss (LA) on Mesial and Buccal Tooth Surfaces During Various Age Periods Based on Mean Increments in Those Who Participated in All Surveys in Norway and Sri Lanka

NORWAY			SRI LANKA		
Age periods years	Mean annual LA rate (mm)		Age periods years	Mean annual LA rate (mm)	
	Mesial	Buccal		Mesial	Buccal
			15-21	0.18	0.18
17-23	0.09	0.14	17-23	0.22	0.21
19-25	0.10	0.13	19-25	0.23	0.23
21-27	0.06	0.11	21-27	0.24	0.24
23-29	0.05	0.09	23-29	0.25	0.22
25-31	0.07	0.09	25-31	0.26	0.21
27-33	0.07	0.08	27-33	0.24	0.23
29-35	0.08	0.11	29-35	0.28	0.25
31-37+	0.08	0.12	31-37+	0.29	0.21

As participants approach 40 years of age almost half the number of the root surfaces have still lost less than 1 mm of their periodontal support and the other 50% have lost between 2 and 4 mm. The individual mean loss

of attachment is slightly above 1.5 mm. This represents approximately 10% of the total periodontal support (Fig. 8) as based on average root lengths in Norwegian teeth.¹⁰ At this point the mean rate of attachment loss is approximately 0.08 mm per year for interproximal surfaces and 0.1 mm for buccal surfaces.

Several aspects of the nature of the development and progress of periodontal disease in this population deserve discussion. First, it is apparent that quantitative reductions of the periodontium start in certain areas prior to reaching the age of 20 years, and that the progress through the twenties and thirties is remarkably constant and slow. Based on the location, extent and rate of progress of these lesions, it can be safely concluded that in this random population of 565 nondental students and academicians, not one case of juvenile periodontitis (periodontosis) or aggressive adult periodontal disease occurred.

Secondly, the observation that the initial loss of attachment took place at the buccal aspects of the roots of bicusps and molars and the fact that these surfaces

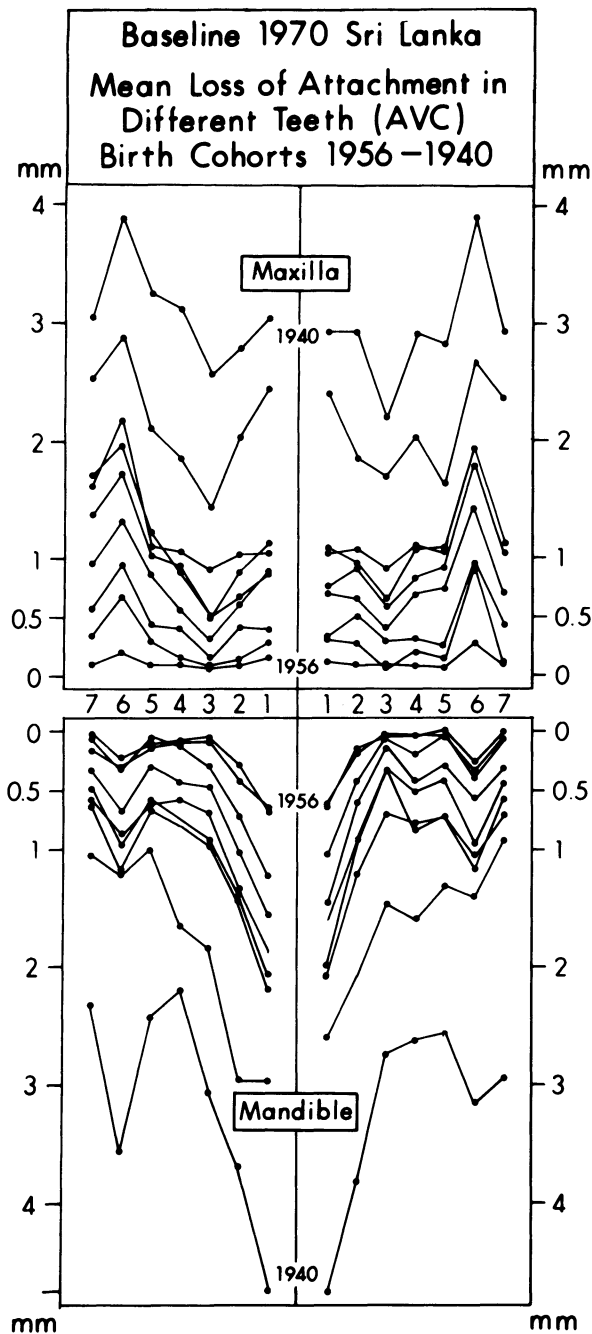


FIGURE 6. Mean loss of attachment in different teeth of Sri Lankan tea laborers aged between 15 and 30+ years.

continued to exhibit the highest rate of progression are contrary to findings in other studies of population groups in this area.¹¹ This discrepancy might be explained by the limitations inherent in the use of roentgenographic techniques in assessing loss of periodontal support on other than interproximal surfaces. However, when loss of attachment was measured in Finnish soldiers aged 19 to 22 years, with a technique similar to the one used in the present study, interproximal loss of attachment was consistently greater than that on facial surfaces. This was particularly true for bicuspid and molars.¹² Preliminary analyses suggest that the initial loss of attachment and the further progress of the lesion on the buccal surfaces

of Norwegian students coincide with a recession of the gingiva and denudation of the root surfaces, whereas loss of attachment on interproximal surfaces is accompanied by deepening of the periodontal pockets. The fact that this group had excellent oral hygiene and a low degree of gingival inflammation on the very same surfaces⁶ and the likelihood that this is accomplished mainly through regular toothbrushing¹³ suggest that the interrelationship of these parameters be thoroughly examined. Correlation studies of the longitudinal relationship between these factors are currently being made.

Only 20% of the 15-year-old Sri Lankans show a quantitatively normal periodontium. However, the ma-

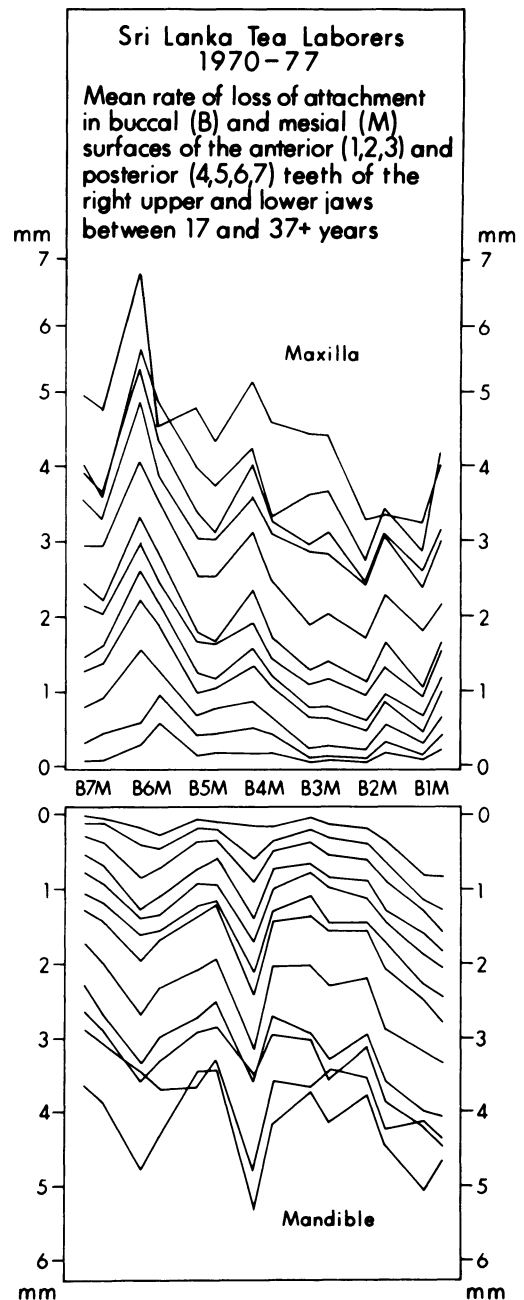


FIGURE 7. Mean rate of attachment loss in buccal (B) and mesial (M) root surfaces of anterior (1, 2, 3) and posterior (4, 5, 6, 7) teeth of Sri Lankan tea laborers between 15 and 37+ years.

TABLE 11. Mean Loss of Attachment on Interproximal Surfaces in Sri Lankan Tea Laborers That Participated in All Four Surveys 1970-1977

Age	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Yr.																									
70		.23		.18	.52	.74	.82	1.00	1.26	2.13	2.09														
		17		18	28	24	28	25	22	18	16														
71			.35	.28	.79	.81	1.12	1.37	1.62	2.28	2.58														
			17	18	28	24	28	25	22	18	16														
73				.84	.94	1.42	1.55	1.90	2.02	2.40	3.29	3.36													
				17	18	28	24	28	25	22	18	16													
77						1.47	1.69	2.14	2.38	2.57	2.77	2.92	3.46	4.01											
						17	18	28	24	28	25	22	18	16											
Cross-sectional means		.28	.49	.77	1.10	1.27	1.66	1.94	2.37	2.88	3.11	3.46	4.01												
		34.5	58	72	95	96.5	104.5	91	85	59	38	18	16												

TABLE 12. Mean Loss of Attachment on Interproximal Surfaces in Sri Lankan Tea Laborers That Participated in All Valid Observation Groups 1970-1977

Age	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Yr.																									
70		.18		.26	.43	.68	.91	1.07	1.16	2.13	3.07														
		40		47	69	62	77	54	61	36	34														
71			.25	.38	.63	.82	1.00	1.45	1.52	2.63	3.40														
			34	40	63	54	65	51	52	32	31														
73				.75	1.05	1.27	1.54	1.86	2.06	2.42	3.49	3.88													
				29	34	54	51	58	43	46	27	27													
77						1.44	1.73	1.97	2.42	2.64	2.67	2.88	3.40	4.32											
						19	22	33	27	32	27	30	19	19											
Cross-sectional means		.23	.46	.68	1.00	1.21	1.56	1.80	2.56	3.20	3.35	3.40	4.32												
		77.5	127	162.5	196.5	203.5	199.5	170.5	145	85	57	19	19												

majority of the 15-year olds exhibit only moderate loss of periodontium. This observation agrees with earlier findings in similar populations in the area.^{3, 4, 14} On the other hand, a fair number of these boys show attachment loss up to 9 mm in mandibular incisors and first maxillary and mandibular molars. At 19 years of age more than 7% display severe degrees of periodontal destruction in these teeth. The localization, severity and general characteristics of these lesions suggest that these individuals suffered from juvenile periodontitis. Despite the occurrence of destruction of this magnitude, the mean annual rate of progress of periodontal disease in these young groups is still relatively low. During the early twenties the loss of attachment rate increases to approximately 0.25 mm per year. A further increase seems to occur during the late twenties and continues throughout the thirties (approximately 0.30 mm per year). Before 40 years of age the dentition of the average Sri Lankan tea

laborer has lost approximately 4.5 mm of its periodontal support. This represents approximately 30 to 35% of the total periodontium (Fig. 9). At this age also more than 7% of the root surfaces have an attachment loss of 10 mm or more and a number of teeth already have been lost due to periodontal disease.¹⁵ Assuming that the same rate of destruction continues during the forties, it can be predicted that an increasing number of teeth will be lost before this population reaches 50 years of age.

A comparison between the frequency, pattern and rate of development of periodontal disease in these two populations shows that quantitative destruction of the periodontium starts earlier in Sri Lankan teenagers than in Norwegian students and that the rate of progress in the different teeth on individual root surfaces is approximately three times greater in the Sri Lankans than in the Norwegians. There is also a distinct difference in the pattern of development between the two. In the Sri

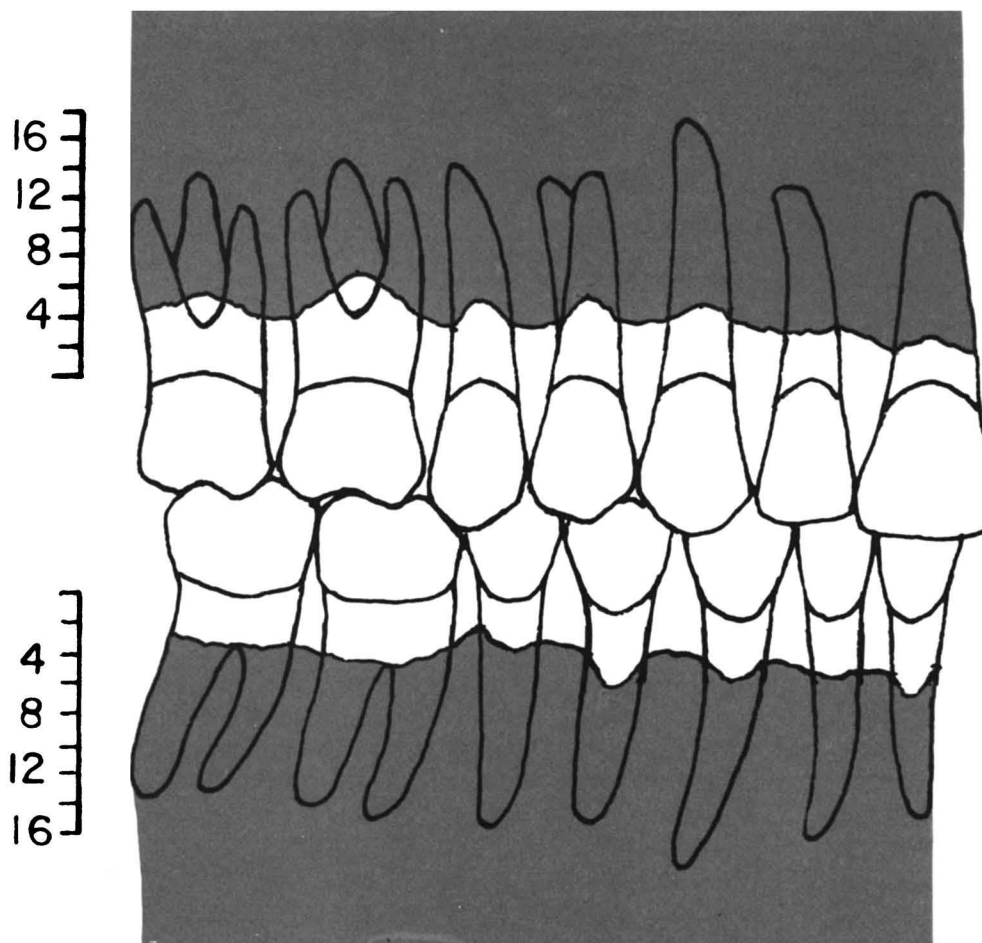


FIGURE 8. Mean periodontal support of the teeth of Sri Lankan tea laborers at approximately 40 years of age.

Lankan tea laborer the initial and progressively worse lesions occur on interproximal and buccal surfaces of mandibular incisors and first molars of both jaws. The Norwegians exhibited the first signs and farthest progress of the attachment loss at the buccal aspects on the first bicuspid and first molars of both jaws. It is tempting to ascribe this phenomenon to the oral hygiene practices of the Norwegians.¹⁶ However, more analyses are in order before such conclusions can be drawn.

Since this study represents the first attempt to describe in a longitudinal fashion the development and progress of periodontal disease in man, it is difficult to find data with which comparisons can be made. However, some short term follow-up studies of patients who have received various forms of periodontal treatment may provide some basis for comparison of rates of progression of the disease. In patients with advanced periodontal disease who had been subjected to surgical therapy and were recalled on a conventional biannual schedule for prophylaxis, loss of attachment continued during the 2 years at a rate of approximately 1 mm per year.¹⁷ This is, of course, an extremely high rate of progress. It is more than 10 times the rate in the 40-year-old Norwegians and exceeds by far the rate of destruction in any individual participants in Sri Lanka as well. In another study¹⁸ groups of patients who were recalled three to four times

per year over a 5-year period showed group mean rates of continued loss of attachment in buccal surfaces between 0.09 and 0.14 mm per year. Finally, it appears from a 3-year study of the effect of controlled oral hygiene procedures on the progression of periodontal disease in adults between 18 and 40 years of age¹⁹ that persons who received frequent oral prophylaxes and personal oral hygiene instructions on a regular basis exhibited an annual rate of attachment loss of approximately 0.03 mm per year, whereas the controls who continued their usual oral hygiene practices and who sought professional care as was their custom, lost approximately 0.10 mm per year.

One important objective of this study was to determine to what extent the advancement of the periodontal lesion is continuous or intermittent. This question may not be fully answered on the basis of clinical measurements, even though in this case individual surfaces of each tooth in the same dentitions were assessed repeatedly at relatively short intervals over a period of years. It is apparent, however, from the Sri Lankan and the Norwegian studies that the destruction of the periodontium progresses steadily over time. There may be periods of slow progress and periods in which the destructive processes show acceleration. Indeed, different surfaces, teeth, dentitions and populations show different rates of progress during

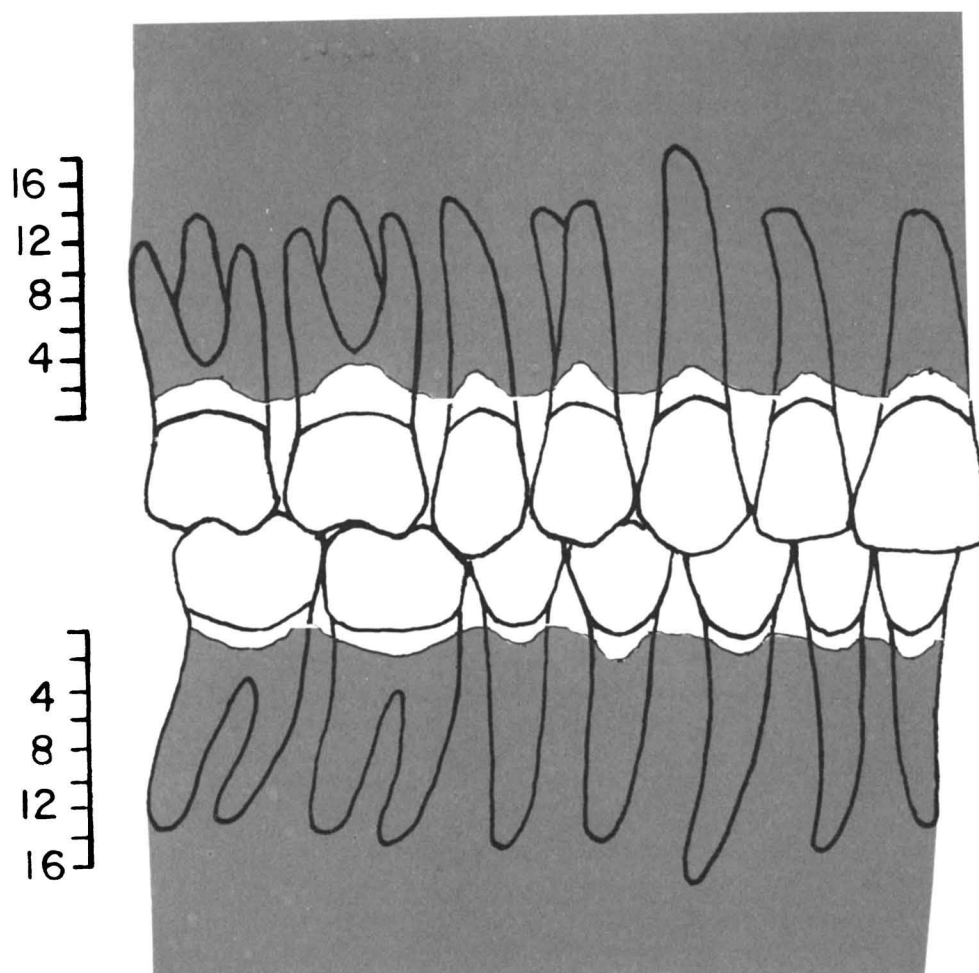


FIGURE 9. Mean periodontal support of the teeth of Norwegian academicians at approximately 40 years of age.

different age periods. These differences most likely reflect variations in both the pathogenic and the defense mechanisms. If these factors are not interfered with by treatment or home care, which was true for the Sri Lankan population, the disease progresses at a relatively even pace and there are no indications that this progress is not continuous.

CONCLUSIONS

This longitudinal study of randomly selected Norwegian students and academicians has shown that 50% of the 17-year olds have lost no periodontal support, and the other 50% exhibited slight localized loss of attachment primarily on buccal surfaces of first molars and first bicuspid of both jaws. At 21 all students show one or more of these lesions as well as loss of attachment on interproximal surfaces. At 30 years of age the mean cumulative loss is still less than 1 mm. As they approach 40 years of age the mean individual loss of attachment is slightly above 1.5 mm or 10% of the total periodontal support, and the mean annual rate of attachment loss is 0.08 for interproximal surfaces and 0.1 mm for buccal surfaces. No case of juvenile periodontitis (periodontosis) or adult aggressive periodontitis were seen in this population.

Seventy percent of the 15-year-old Sri Lankans have no or very little loss of periodontal support. However, approximately 30% exhibit localized lesions measuring between 2 and 9 mm and more than 1% have one or more root surfaces with 10 mm loss of attachment or more. In this age group the lesions occur at the interproximal and buccal aspects of lower central incisors and in first molars of both jaws. At 30 years of age the mean loss of attachment is 3.11 mm and approximately 25% of the tea laborers have lesions extending 10 mm or more below the cemento-enamel junction. As the Sri Lankan approaches 40 years of age the mean loss of attachment is 4.50 mm and the mean rate of progress of the lesion is 0.20 mm per year for buccal surfaces and 0.30 mm for interproximal surfaces. This study suggests that without interference the periodontal lesion progresses at a relatively even pace and that the progress is continuous.

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Announcements

INTERNATIONAL SYMPOSIUM ON PHENYTOIN-INDUCED TERATOLOGY AND GINGIVAL PATHOLOGY

An international symposium on Phenytoin-Induced Teratology and Gingival Pathology will be held in Chapel Hill, NC, May 25 and 26, 1979. In this symposium, clinicians and basic scientists in various disciplines will present their recent research relating to the orofacial manifestations associated with chronic phenytoin therapy. The main conference topics will be "drug metabolism and disposition," "teratology," and "gingival overgrowth." A panel discussion will encourage audience participation. For information and preregistration packet contact: Dr. Thomas M. Hassell, Department of Periodontics, School of Dentistry, University of North Carolina, Chapel Hill, NC 27514 U.S.A.

THE UNIVERSITY OF SOUTHERN CALIFORNIA SCHOOL OF DENTISTRY

The University of Southern California will have its fifth annual periodontal symposium on January 26th and 27th, 1979. The timely topic this year will be: "Scaling and Curettage—Is it Enough." The speakers will include Leonard Hirschfeld, S. Sigmund Stahl, Sigurd Ramfjord, Harold Slavkin, Jan Lindhe, Saul Schluger, and John Prichard. Arnold A. Ariaudo will be the program chairman and John S. Sottosanti will be the moderator. For further information please contact the Department of Continuing Education, U.S.C. School of Dentistry, 925 W. 34th Street, Los Angeles, California, 90007.