

Natural history of periodontal disease in man

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Rapid, moderate and no loss of attachment in Sri Lankan laborers 14 to 46 years of age

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Abstract. This paper describes the initiation, rate of progress of periodontal disease and consequent tooth loss in a population never exposed to any programs or incidents relative to prevention and treatment of dental diseases. The group consisted of 480 male laborers at two tea plantations in Sri Lanka. The study design and baseline data have been published. At the initial examination in 1970, the age of the participants ranged between 14 and 31 years. Subsequent examinations occurred in 1971, 1973, 1977, 1982 and 1985. Thus, the study covers the age range 14-46 years. Throughout the study, the clinical indices were scored by the same two examiners, both well-trained and experienced periodontitis. Intra-examiner reproducibility for each index was tested at baseline and repeated periodically during the study. The data for each examination were computerized and updated on an ongoing basis. At the last examination in 1985, there were 161 individuals who had participated in the first survey. This population did not perform any conventional oral hygiene measures and consequently displayed quite uniformly large aggregates of plaque, calculus and stain on their teeth. Virtually all gingival units exhibited inflammation. Based on interproximal loss of attachment and tooth mortality rates, three subpopulations were identified: (1) individuals (~8%) with rapid progression of periodontal disease (RP), those (~81%) with moderate progression (MP), and a group (~11%) who exhibited no progression (NP) of periodontal disease beyond gingivitis. At 35 years of age, the mean loss of attachment in the RP group was ~9 mm, the MP group had ~4 mm and the NP group had less than 1 mm loss of attachment. At the age of 45 years, the mean loss of attachment in the RP group was ~13 mm and the MP group ~7 mm. The annual rate of destruction in the RP group varied between 0.1 and 1.0 mm, in the MP group between 0.05 and 0.5 mm, and in the NP group between 0.05 and 0.09 mm. Since this population was virtually caries free, essentially all missing teeth were lost due to periodontal disease. In the RP group, tooth loss already occurred at 20 years of age and increased throughout the next 25 years. At 35 years of age, 12 teeth had been lost, at 40 years of age 20 teeth were missing and at 45 all teeth were lost. In the MP groups, tooth mortality started after 30 years of age and increased throughout the decade. At 45 years of age, the mean loss of teeth in this group was 7 teeth. The NP group essentially showed no tooth loss.

Key words: Natural history – periodontal disease – loss of attachment – tooth loss.

Almost all of our knowledge of periodontal morbidity and tooth mortality of the human dentition stems from cross-sectional studies of populations of different age and in various geographic areas. Longitudinal investigations in which the total sequence from initial development, progression of the disease into deeper parts of the periodontium and resultant tooth loss is assessed as

a function of time, are virtually nonexistent.

The material presented here is derived from an investigation of the natural history of periodontal disease in a population never exposed to any programs or incidents relative to prevention and treatment of dental diseases. This paper describes the initiation, rate of progress of periodontal disease and

consequent tooth loss between 14 and 46 years of age.

Material and Methods

The longitudinal group was established in Sri Lanka in 1970 (Løe et al. 1978a) and consisted of 480 male tea laborers between 14 and 30 years of age who worked at the Dunsinane and Harrow

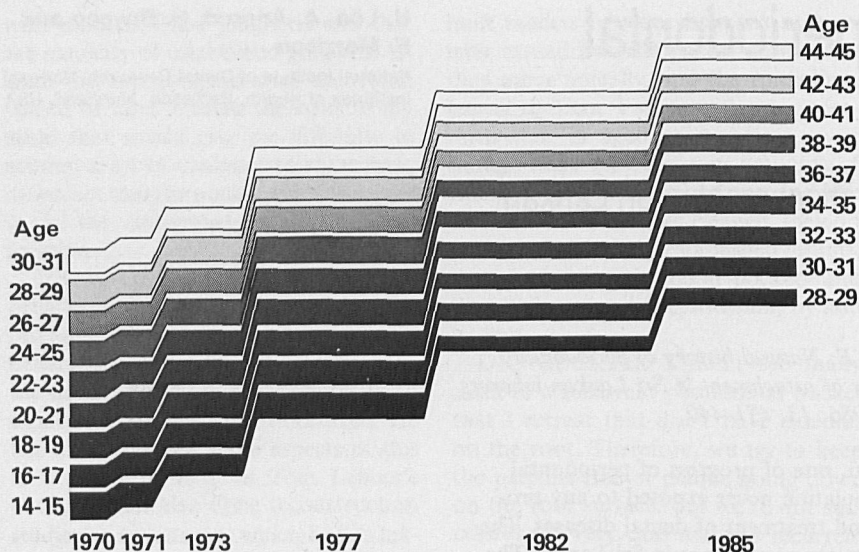


Fig. 1. Age cohorts at base line and subsequent reexamination in Sri Lanka.

Alterskohorten bei der Ausgangsuntersuchung und den dann folgenden Nachuntersuchungen in Sri Lanka.

Groupes d'âge lors de l'examen initial et des examens subséquents à Sri Lanka.

Tea Estates (Fig. 1). These two plantations are situated in the central highland approximately 50 miles from Kandy and their population totals approximately 5,000. The participants were all Tamils and descendents of groups who two to three generations ago emigrated from Southern India. For further details on the design of the study and the baseline data, see Løe et al. (1978a).

A cross-sectional sample was selected from the Sheen Estate, a neighbor plantation in January 1985, and consisted of 169 male tea laborers between 25 and 71 years of age.

Clinical examinations

The longitudinal Sri Lankan group was first examined in 1970. The group was reexamined in 1971, 1973, 1977, 1982 and 1985. The time span between the first and the sixth examination was 15 years.

At each appointment, the participants answered questions regarding smoking and betel chewing habits. Missing teeth were recorded in all participants at each appointment (Løe et al. 1978b). The clinical examination of the periodontal tissues and adjacent portions of the dentition included measurements and scoring of the indices on all mesial and facial surfaces of all teeth, except third molars. The following indices or measurements were recorded:

gingival index (GI) (Løe & Silness 1963)
loss of attachment (LA) (Glavind & Løe 1967)
plaque index (PII) (Silness & Løe 1964)
calculus index (CI) (Løe 1967)
gingival caries index (CaI) (Løe 1967).

At each examination throughout the study, the same indices were scored by the same two investigators, who were both well-trained and experienced periodontists. All scores were dictated to the chairside assistant who recorded the scores on a special scoring chart (Løe et al. 1978a).

The sequence of scoring was always the same: plaque, calculus, and caries including DMFS 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 from the cementum-enamel junction (Løe et al. 1978). These measurements were made with a blunt probe graded at 1, 2, 3, 4, 5, 7, 9 and 11 mm. The diameter of the probes was 0.6 mm. The same probes were used for all six surveys.

The plantation group in Sri Lanka was examined in an outdoor facility comprising two portable dental chairs and supporting equipment, but no compressed air and saliva ejectors. Two dental students assisted each investigator

during the scoring and in recording the scores.

Intra-examiner reproducibility for each index was tested at baseline and repeated periodically throughout the study.

Data analysis

The data for each examination in Sri Lanka were computerized and updated on an ongoing basis. As with most studies of this size, a certain number of the population dropped out and could not be followed-up. Table 1 gives the number of individuals who participated in each survey by birth cohort. The Sri Lankan group suffered from a repatriation program which was unknown to the investigators at the start of the study. During the examination in 1977 Sri Lankan authorities confirmed that the program had been terminated and there were no plans for its reactivation. Up to the age of 37 years, the loss of population to follow-up appeared to be independent of age.

When no significant changes in the estimates of the parameters occurred over time, the birth cohorts were collapsed into age cohorts which describes the population over 30 years. In order to get a complete picture of the development of the disease from the youngest to the oldest age group observed, cross-sectional means were calculated. They are averages of each age group as the birth cohort moves longitudinally. Thus, the development of the disease is traced from age 14 to 46 in Sri Lanka.

Data analyses were performed on all the valid observation group (AVO). 88 individuals were present in all 6 surveys (IAS). In a previous report, the IAS group was compared to the total AVO group on each specified clinical index to determine if those lost to follow-up were significantly different from those that remained in the study. Certain rates such as the tooth mortality rate, were based on all individuals (161) who appeared at both the 1st and 6th surveys.

Based on interproximal loss of attachment and tooth mortality, 3 subpopulations were identified:

- (1) Subjects were assigned to the rapid progression (RP) subgroup based on one of two patterns of periodontal destruction:
 - (1) Before the age of 21 years, the subject must have a minimum of 4 mm loss of attachment on at least 2 permanent molars and incisors,

Table 1. Number of Sri Lankan Tea laborers who participated in each survey (by birth cohort, 1970–1985)

Year of Birth	1970	1971	1973	1977	1982	1985
1939	1	1	1	0	0	0
1940	33	30	26	19	11	12
1941	19	17	16	10	8	6
1942	17	15	11	9	6	5
1943	22	19	17	14	7	8
1944	39	33	29	15	14	11
1945	24	24	20	11	10	9
1946	30	28	23	17	12	13
1947	39	33	30	16	12	14
1948	38	33	28	16	13	15
1949	24	24	21	11	6	8
1950	38	30	30	16	14	12
1951	37	34	30	22	13	12
1952	32	30	24	11	13	11
1953	28	24	21	12	5	7
1954	19	16	14	10	6	7
1955	38	32	28	19	9	11
1956	2	2	1	0	0	0
Total	480	425	370	228	159	161

Table 2. Cumulative number of observations in each age category and disease group for all participants (AVO) and for those who appeared in all six surveys (IAS) (in parenthesis), 1970–1985

Age Years	RP	MP	NP
14		1	1
15	3 (2)	17 (4)	20
16	4 (3)	27 (6)	21
17	2 (1)	28 (5)	16
18	6 (3)	51 (13)	25
19	8 (3)	54 (16)	23
20	10 (1)	65 (17)	17
21	6 (1)	59 (16)	14
22	10 (3)	83 (17)	16
23	6 (1)	92 (18)	13
24	8 (1)	82 (18)	5
25	13 (3)	78 (25)	4
26	11 (2)	95 (20)	6
27	8 (4)	89 (26)	4
28	11 (4)	63 (16)	2
29	3 (1)	78 (21)	2
30	7 (5)	108 (39)	1
31	7 (3)	63 (24)	2
32	4 (1)	44 (21)	1
33	1 (1)	57 (19)	1
34	3 (2)	42 (23)	1
35	2 (1)	25 (10)	1
36	1 (1)	33 (15)	
37	1 (1)	43 (18)	
38		24 (10)	
39	3 (3)	16 (11)	
40	3 (2)	14 (6)	
41		16 (11)	
42		17 (13)	
43	1 (1)	7 (5)	
44		8 (5)	
45		6	

one of which must be a first molar. No more than 2 teeth other than first molars and incisors should have 5 mm loss of attachment, or (2) A subject before the age of 30 must have at least 8 teeth missing due to periodontal disease or with loss of attachment of 5 mm or more. At least 3 of the diseased or missing teeth should be other than first molars or incisors.

(II) Subjects with loss of attachment not exceeding 2 mm on any mesial surface at any survey were assigned to the group with no disease progression (NP).

(III) The group with moderate progression (MP) consisted of all subjects not identified in the foregoing categories.

Subjects retained subpopulation identification for descriptive analyses at all age intervals. The number of observations in each age-specific cohort are presented for the three disease groups in Table 2.

In an earlier report (Löe et al. 1978c), we described the longitudinal loss of attachment on the basis of measurements on buccal and mesial tooth surfaces. Due to indications that in some populations the buccal surfaces are subject to various mechanical impacts during tooth cleaning and the oral habits which may result in loss of periodontal tissues, the present report describes the initiation and progress of the periodontal lesion on mesial surfaces. Since mesial and adjacent distal surfaces have been shown to exhibit similar characteristics (Schei et al. 1959) this study may be taken to reflect the pattern of initiation and advancement of periodontal disease in the interdental areas of the dentition.

Results

This population did not perform any conventional oral hygiene measures and consequently displayed quite uniformly large aggregates of mineralized and non-mineralized debris and stain on their teeth. All participants exhibited inflammatory changes in the majority of the gingival units. At 15 years of age the mean gingival index was 1.3 and approximately 30 percent of the interproximal areas scored GI=2. At 20, mean gingival index was 1.6 and approximately 60 percent of the interdental areas scored GI=2. The 30-year-olds had mean GI=1.9 and almost 90% of the interdental areas scored GI=2

(Anerud et al. 1979). After 40 years of age all interdental areas bled on probing (GI=2).

At the baseline examination in 1970, 20% of the 15-year-olds showed no loss of periodontal attachment (Løe et al. 1978c). An additional 50% of this group showed a maximum loss of attachment at any one site of 1 mm. Approximately 96% of the total number of interproximal surfaces measured 0 or 1 mm loss of attachment. The mean attachment loss for the group was 0.17 mm. However, approximately 30% of the 15-years-old showed one or more lesions measuring between 2 and 9 mm, and 1% of this age group exhibited one or more interproximal areas which had lost more than 10 mm. When loss of attachment occurred in this age group, it was often confined to mandibular central incisors and first molars of both jaws.

Above 20 years of age, all participants showed loss of attachment of various degrees. In the 30-year-old Sri Lankan, the mean interproximal attachment loss was ~3.5 mm; at 40, the mean loss of attachment was ~5 mm; and at 45, it had increased to ~6.0 mm (Fig. 2). The cross-sectional study performed in 1985 essentially confirmed these stages in the progression of the periodontal destruction (Fig. 2). Also, as is apparent from this diagram the mean interproximal loss of attachment calculated on the basis of measurements in those who participated in all surveys did not differ significantly from that derived from all valid observations.

The same was true for tooth loss. The cross-sectional means (Table 3) shows

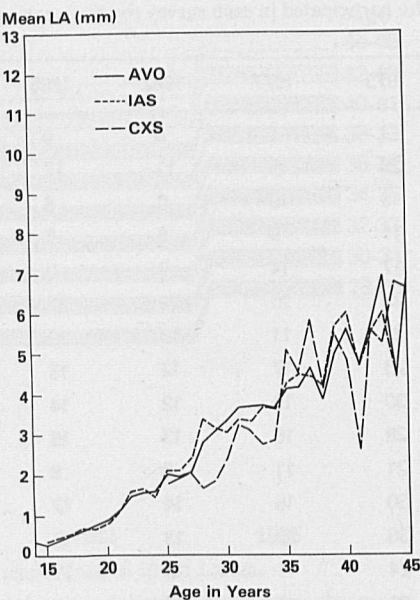


Fig. 2. Mean loss of attachment (LA) on mesial root surfaces – Sri Lanka. Based on all valid observations (AVO), on participation in all surveys (IAS) and on cross sectional (CXS) data.

Mittlerer Attachmentverlust (LA) an mesialen Wurzeloberflächen – Sri Lanka. Von allgemeingültigen Beobachtungen (AVO), von der Teilnahme an allen Untersuchungen (IAS) und von Querschnitts-(CXS) Daten ausgehend.

Perte d'attache moyenne (LA) au niveau des surfaces radiculaires mésiales à Sri Lanka basée sur toutes les observations valables (AVO), sur la participation à toutes les enquêtes (IAS), et sur les données par recoupement (CXS).

that the 15-years-old had an average of 27.8 teeth present. At 20 years of age,

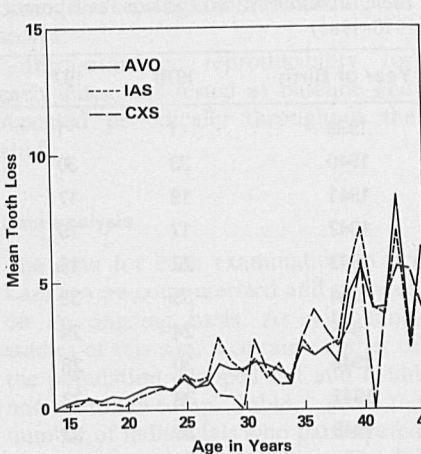


Fig. 3. Mean tooth loss – Sri Lanka. Based on all valid observations (AVO), on participation in all surveys (IAS) and on cross sectional (CXS) data.

Zahnverlust im Mittel – Sri Lanka. Von allgemeingültigen Beobachtungen (AVO), von der Teilnahme an allen Untersuchungen (IAS) und von Querschnitts-(CXS) Daten ausgehend.

Perte dentaire moyenne à Sri Lanka basée sur toutes les observations valables (AVO), sur la participation à toutes les enquêtes (IAS), et sur les données par recoupement (CXS).

the number of teeth present dropped to 27.5 and the 30 year old averaged 26.4 teeth. By the age of 40 the number of teeth had decreased to 22.4; and at 45 an average of 21.8 teeth were present. When only those who participated in all surveys were considered, it was apparent that similar decreases had taken place. Fig. 3 shows that tooth loss in the cross-sectional study (CXS) in 1985

Table 3. Average number of teeth present in Sri Lankan tea laborers (AVO)

Years of 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	39	40	41	42	43	44	45	46
1970	28.00 (2)	27.74 (38)	27.45 (20)	27.86 (28)	27.65 (31)	27.70 (38)	27.42 (38)	27.52 (23)	27.16 (38)	27.31 (39)	26.97 (30)	26.79 (24)	27.38 (39)	27.23 (22)	25.35 (17)	26.26 (19)	26.67 (33)	28.00 (1)															
1971		28.00 (32)	27.69 (17)	27.18 (23)	27.79 (30)	27.30 (35)	27.69 (30)	27.13 (23)	27.48 (32)	26.84 (34)	27.18 (28)	26.86 (24)	26.62 (33)	27.15 (19)	27.05 (15)	25.47 (17)	26.00 (30)	26.40 (1)	28.00 (1)														
1973				25.00 (1)	27.46 (28)	27.06 (17)	27.32 (19)	27.28 (25)	27.03 (29)	27.07 (30)	27.50 (20)	26.62 (29)	27.14 (28)	26.62 (24)	25.95 (21)	26.52 (27)	26.94 (18)	24.17 (12)	24.80 (15)	26.12 (26)	28.00 (1)												
1977								26.00 (1)	26.58 (19)	26.70 (10)	27.64 (11)	26.86 (14)	27.00 (21)	27.00 (13)	27.00 (13)	27.20 (15)	27.30 (20)	26.15 (13)	25.50 (10)	27.06 (17)	26.06 (17)	23.50 (6)	25.09 (11)	25.82 (17)									
1982														27.22 (9)	25.33 (6)	27.17 (6)	27.12 (16)	27.27 (11)	27.33 (12)	26.43 (7)	26.93 (14)	26.55 (11)	25.82 (11)	24.45 (11)	26.47 (15)	23.33 (6)	20.29 (7)	23.00 (6)	23.36 (11)				
1985																	25.00 (1)	25.00 (12)	26.60 (5)	27.64 (11)	26.44 (9)	27.29 (14)	25.64 (11)	26.67 (12)	25.94 (16)	25.56 (9)	23.46 (13)	23.80 (10)	24.70 (10)	25.17 (6)	19.62 (8)	25.25 (8)	21.67 (6)
Cross-Sectional Means	28.00 (2)	27.75 (40)	27.60 (52)	27.54 (46)	27.62 (82)	27.44 (85)	27.50 (92)	27.28 (79)	27.09 (109)	27.04 (111)	27.23 (95)	26.77 (95)	27.09 (112)	27.03 (101)	26.22 (76)	26.42 (83)	26.44 (116)	26.15 (72)	26.27 (49)	26.47 (59)	26.74 (46)	25.54 (28)	25.89 (34)	25.52 (44)	26.12 (24)	23.42 (19)	22.35 (17)	24.06 (16)	24.00 (17)	19.62 (8)	25.25 (8)	21.67 (6)	

Table 4. Frequency distribution of teeth lost in 161 Sri Lankan tea laborers in 15 years, 1970–1985

Number of Teeth lost	(333) Teeth	Number of Individuals
0		67
1		32
2		23
3		14
4		6
5		4
6		3
7		1
8		1
10		1
11		3
12		1
14		1
15		2
16		1
21		1

did not differ significantly from that calculated on the basis of those participating in all surveys (IAS) or on all valid observations (AVO) during the longitudinal study.

In the 161 individuals who participated in the first and sixth surveys, 333 teeth were lost during the 15 years. As can be seen from Table 4, the majority of teeth lost occurred in approximately one-third of the group.

As the study of this material continued, it became evident that both the onset of periodontal destruction and its progression varied greatly between individuals. On the basis of the disease profiles and characteristics (criteria described in the Material and Methods

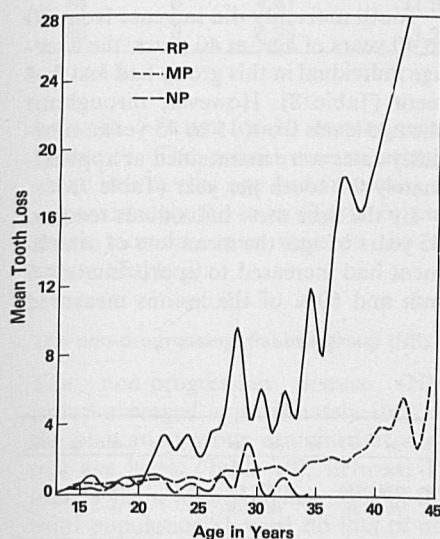


Fig. 4. Mean tooth loss – Sri Lanka (all valid observations).

Mittlerer Zahnverlust – Sri Lanka (allgemeingültige Beobachtungen).

Perte dentaire moyenne à Sri Lanka (toutes les observations valables).

Table 5. Frequency and degree of attachment loss (LA) in mesial root surfaces in Sri Lankan tea laborers between 14 and 46 years of age (rapid disease progression)

Age	Number	Mean LA mm	Percent 0-1 mm	Measurements 2-4 mm	Measurements 5-9 mm	Loss ≥ 10 mm
15	3	0.64	90.12	7.41	1.23	1.23
16	4	0.93	82.41	12.96	2.78	1.85
17	2	1.17	81.82	12.73	1.82	3.64
18	6	1.69	58.28	37.42	3.07	1.23
19	8	1.28	75.23	19.72	3.21	1.83
20	10	1.85	62.64	26.74	7.33	3.30
21	6	2.01	47.59	44.58	6.02	1.81
22	10	2.87	43.32	38.99	10.47	7.22
23	6	4.07	22.75	48.50	16.77	11.98
24	8	3.56	39.15	33.02	16.98	10.85
25	13	4.29	26.98	41.35	16.13	15.54
26	11	4.29	12.58	51.32	27.15	8.94
27	8	4.89	18.36	37.20	30.43	14.01
28	11	5.68	10.77	38.38	32.32	18.52
29	3	8.79	0.00	12.82	46.15	41.03
30	7	5.21	6.28	48.17	28.80	16.75
31	7	6.02	18.03	33.88	21.86	26.23
32	4	5.61	1.96	35.29	48.04	14.71
33	1	4.57	14.29	64.29	0.00	21.43
34	3	5.15	9.76	46.34	26.83	17.07
35	2	9.06	4.26	8.51	34.04	53.19
36	1	6.64	4.55	50.00	9.09	36.36
37	1	10.75	0.00	0.00	35.71	64.29
39	3	9.99	0.00	11.39	26.58	62.03
40	3	11.18	0.00	1.19	27.38	71.43
43	1	13.00	0.00	0.00	0.00	100

section) it was possible to identify 3 sub-populations of the longitudinal plantation group. (1) A relatively small group of individuals with rapidly progressing disease (RP), (2) a large group consisting of those with moderately progressing disease (MP), and (3) a small group of participants who showed essentially no progress of the disease process (NP) (Fig. 4).

The rapidly progressing disease group (RP)

The group with rapidly progressing periodontal disease (RP) comprised approximately 8 percent of the total population at all age levels. At 15 years of age this group showed a mean loss of attachment of 0.64 mm (Table 5). 90% of the interproximal areas exhibited loss of attachment less than 2 mm. However, approximately 1% of the surfaces already showed attachment loss between 5 and 9 mm and another 1% exhibited areas with attachment loss of 10 mm or more. Both the mean loss of attachment and the frequency of deeper lesions increased during the remainder of the teens. The rate of attachment loss between 15 and 20 years of age was 0.13

mm per year (Table 6). The lesions were mainly confined to incisors (I) and first molars (M) (Fig. 5), at which sites the rate of progression was much higher and often leading to loss of these teeth before 20 years of age.

Both the mean loss of attachment and tooth loss increased during the twenties. At 25 years of age the mean LA was 4.3 mm and the mean tooth loss was 5.9 teeth. At this stage, periodontal destruction occurred in all teeth at a mean rate of approximately 0.5 mm per year, and the mean annual rate of tooth loss was 0.40 (Table 7).

The annual tooth mortality continued to increase towards the age of 30 (Table 8) at which time this group of individuals had lost approximately 9

Table 6. Annual rate of attachment loss (LA) on mesial surfaces during various age periods – Sri Lanka (all valid observations)

Age Periods Years	Mean Annual LA Rate (mm)		
	RP	MP	NP
14-19	0.13	0.05	0.05
20-24	0.46	0.11	0.05
25-29	1.04	0.29	0.09
30-34	0.73	0.14	0.05
35-39	0.97	0.09	0.04
40-44	0.60	0.07	
45		0.52	

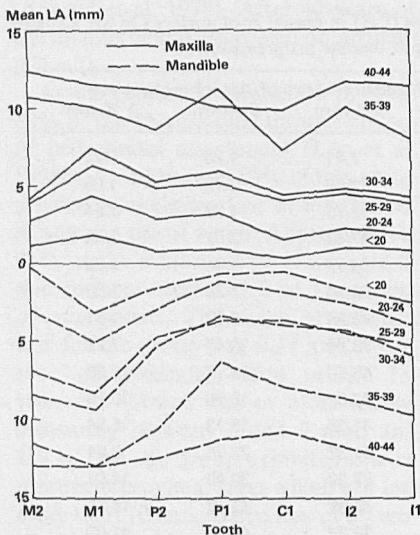


Fig. 5. Mean loss of attachment - Sri Lanka. Five year age groups in maxillary and mandibular teeth (rapidly progressing disease).

Mittlerer Attachmentverlust – Sri Lanka. 5-Jahres Altersgruppen bei Oberkiefer- und Unterkieferzähnen. (Krankheit mit rapider Progression).

Perte d'attache moyenne à Sri Lanka. Groupes d'âge par 5 ans, pour les dents supérieures (Maxilla) et inférieures (Mandible) (Maladie à progression rapide: RP).

teeth. The mean loss of attachment at this stage was 5.2 mm and only 13% of the lesions measured less than 4 mm; approximately 46% of the interproximal areas had between 5 and 9 mm attachment loss; and approximately

Table 7. Annual rate of tooth mortality during various age periods - Sri Lanka (all valid observations)

Age Periods Years	Mean Annual Tooth Mortality Rate		
	RP	MP	NP
14-19	0.03	0.11	0.12
20-24	0.40	0.02	0.12
25-29	1.43	0.12	0.10
30-34	1.00	0.04	0.10
35-39	2.33	0.27	0.00
40-44	2.33	0.08	
45		0.71	

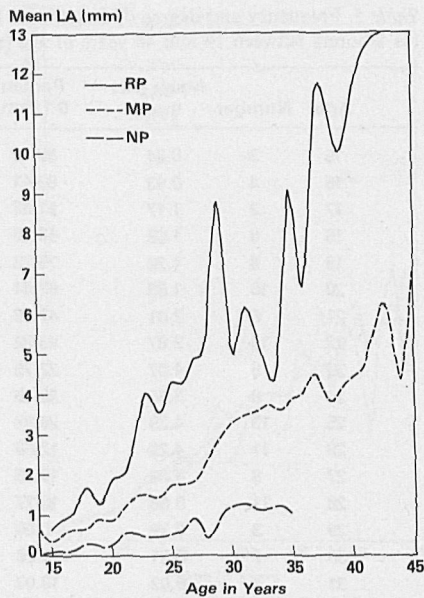


Fig. 6. Mean loss of attachment - Sri Lanka (mesial root surfaces for all valid observations).

Mittlerer Attachmentverlust – Sri Lanka
(Mesiale Wurzeloberflächen bei allgemeingül-
tigen Beobachtungen).

Perte dentaire moyenne à Sri Lanka (surfaces radiculaires mésiales pour toutes les observations valables).

40% measured 10 mm or more (Table 5). The annual loss of attachment rate at 30 years of age was 1.04 mm (Table 6).

Between 30 and 40 years of age, the mean loss of attachment increased to approximately 11.2 mm. All teeth exhibited advanced periodontal destruction which progressed at a rate approximately 1 mm per year. By 40 years of age, approximately 20 teeth had been lost (Fig. 4) and mean tooth mortality rates had increased to 2.3 teeth per year (Table 7). Between 40 and 45 years of age, the individuals afflicted with rapid progressing periodontal disease (RP) essentially lost all their teeth.

The moderately progressing disease group (MP)

The group characterized by a moderately progressing periodontal disease (MP) numbered 145 individuals and comprised approximately 80% of the total population. At 15 years of age, the mean LA of this group was 0.35 mm, 93% of the lesions measured less than 2 mm (Table 9). However, loss of attachment between 5 and 9 mm as well as 10 mm and beyond did occur. Mean loss of attachment increased throughout the remainder of the teens and measured approximately 0.9 mm at the age of 20 years. Mean loss of attachment rate before 20 years of age was 0.05 mm (Table 6). Tooth loss before 20 years of age was negligible (Fig. 4, Table 8).

The loss of attachment increased during the twenties; at 25 years the mean loss of attachment was approximately 1.8 mm, rising to 3.2 mm by the age of 30 years. During these years, the annual LA rate rose to 0.3 mm. Tooth loss was still modest and progressed at a rate of 0.10 tooth per year. Between 30 and 40 years of age, the destruction of the periodontium continued at a relatively even pace. At 35 years of age the mean loss of attachment was 3.9 mm, with approximately 60% of the lesions measuring 4 mm or less. All interdental areas of the dentition were involved (Fig. 7) and the rate of progress of the lesions averaged approximately 0.1 mm per year (Table 6).

Tooth mortality did increase from 30 to 40 years of age; at 40 years, the average individual in this group had lost 3–4 teeth (Table 8). However, throughout the age levels from 15 to 45 years, mortality rates were maintained at approximately 0.1 tooth per year (Table 7).

By the time these individuals reached 45 years of age, the mean loss of attachment had increased to approximately 7 mm and 60% of the lesions measured

Table 8. Average number of teeth present in Sri Lankan tea laborers three subpopulations

[illegible]

Table 9. Frequency and degree of attachment loss (LA) in mesial root surfaces in Sri Lankan tea laborers between 14 and 46 years of age (moderate disease progression)

Age	Number	Mean LA	Percent Measurement of Attachment Loss			
		mm	0-1 mm	2-4 mm	5-9 mm	≥10 mm
14	1	0.67	92.59	7.41	0.00	0.00
15	17	0.35	94.59	3.90	0.43	1.08
16	27	0.52	92.97	4.86	0.14	2.03
17	28	0.65	92.78	4.99	0.26	1.97
18	51	0.70	90.61	7.33	0.21	1.85
19	54	0.92	84.27	12.97	0.74	2.02
20	65	0.88	83.90	14.53	0.34	1.23
21	59	1.17	79.43	16.93	1.11	2.52
22	83	1.46	69.15	26.83	1.23	2.80
23	92	1.53	68.19	26.68	2.21	2.92
24	82	1.45	68.64	26.76	2.21	2.39
25	78	1.71	64.17	29.31	3.17	3.36
26	95	1.77	59.50	35.24	2.29	2.97
27	89	1.87	54.96	38.70	3.54	2.80
28	63	2.36	45.05	45.80	4.26	4.89
29	78	2.90	37.49	44.18	12.67	5.66
30	108	3.22	29.27	50.27	13.84	6.62
31	63	3.48	24.13	51.04	18.59	6.24
32	44	3.56	17.51	60.22	15.76	6.51
33	57	3.75	14.91	56.88	21.92	6.30
34	42	3.60	16.48	56.70	22.09	4.73
35	25	3.86	15.28	54.90	21.96	7.86
36	33	4.10	17.57	53.04	18.36	11.04
37	43	4.50	14.06	46.25	28.65	11.04
38	24	3.86	16.67	54.89	20.34	8.10
39	16	4.05	11.45	63.08	14.95	10.51
40	14	4.43	15.80	51.50	18.53	14.17
41	16	4.70	14.65	48.51	21.05	15.79
42	17	5.73	7.13	35.85	39.96	17.06
43	7	6.07	5.18	38.86	32.64	23.32
44	8	4.41	11.52	54.38	21.66	12.44
45	6	6.99	1.23	36.20	33.74	28.83

between 5-9 mm or 10 mm or more (Table 9). The annual rate of attachment loss at this age had increased to approximately 0.5 mm (Table 6) and tooth mortality rates were on the increase (Table 7).

The non-progressing disease group (NP)

The non-progressing disease (NP) group averaged approximately 10% of the plantation group examined at various age levels (Table 10). Between 15 and 19 years, approximately 35% of the total population showed no loss of attachment beyond 2 mm at any one site. At 25, there were still 13% of the cohort who had not developed periodontal destruction to any degree. Between 30 and 35, the mean loss of attachment was still approximately 1 mm (Fig. 8), advancing

toward the age of 40 at a rate of 0.05 mm per year (Table 6).

Tooth loss was inconspicuous (Table 8) and did not seem to increase as the individuals approached 40 years of age (Table 7).

Plaque, gingivitis, calculus and caries in the subpopulations

At 15 years of age, the group with rapid developing periodontal (RP) disease had a mean plaque index score of 2.04, reflecting the presence of visible plaque in all interdental areas. 96% of the surface scored PII=2 and the rest scored PII=3. This level of oral hygiene was basically maintained through the next 30 years. The group with moderately progressing (MP) and non-progressing (NP) disease were not much different.

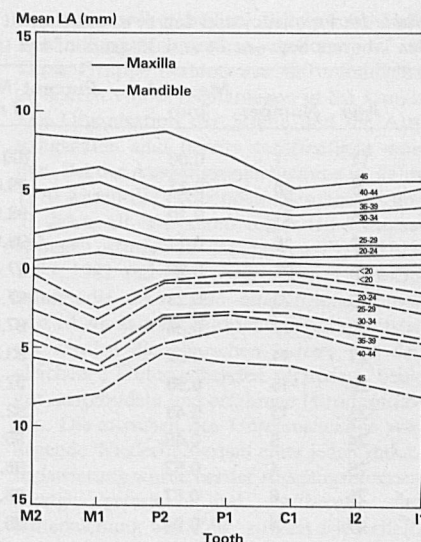


Fig. 7. Mean loss of attachment – Sri Lanka. Five year age groups in maxillary and mandibular teeth (moderately progressing disease).

Mittlerer Attachmentverlust – Sri Lanka. 5-Jahres Altersgruppen bei Oberkiefer- und Unterkieferzähnen (Krankheit mit mässiger Progression).

Perte d'attache moyenne à Sri Lanka. Groupes d'âge par 5 ans, pour les dents supérieures (Maxilla) et inférieures (Mandible). (Maladie à progression modérée: MP).

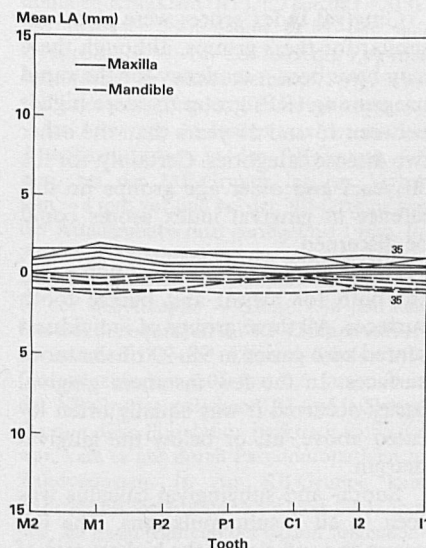


Fig. 8. Mean loss of attachment – Sri Lanka. Five year age groups in maxillary and mandibular teeth (no disease progression).

Mittlerer Attachmentverlust – Sri Lanka. 5-Jahres Altersgruppen bei Oberkiefer- und Unterkieferzähnen. (Keine Progression der Krankheit).

Perte d'attache moyenne à Sri Lanka. Groupes d'âge par 5 ans, pour les dents supérieures (Maxilla) et inférieures (Mandible). (Groupe sans progression de la maladie: NP).

Table 10. Frequency and degree of attachment loss (LA) in mesial root surfaces in Sri Lankan tea laborers between 14 and 35 years of age (no disease progression)

Age	Number	Mean LA mm	Percent Measurements of Attachment Loss			
			0-1 mm	2-4 mm	5-9 mm	≥ 10 mm
14	1	0.00	100	0.00	0.00	0.00
15	20	0.11	99.81	0.19	0.00	0.00
16	21	0.10	98.96	1.04	0.00	0.00
17	16	0.14	99.09	0.91	0.00	0.00
18	25	0.28	97.40	2.60	0.00	0.00
19	23	0.23	97.44	2.56	0.00	0.00
20	17	0.28	97.58	2.42	0.00	0.00
21	14	0.52	93.03	6.97	0.00	0.00
22	16	0.55	92.06	7.94	0.00	0.00
23	13	0.49	92.29	7.71	0.00	0.00
24	5	0.49	95.71	4.29	0.00	0.00
25	4	0.53	96.36	3.64	0.00	0.00
26	6	0.67	95.18	4.82	0.00	0.00
27	4	0.94	85.98	14.02	0.00	0.00
28	2	0.44	92.45	7.55	0.00	0.00
29	2	0.97	81.82	18.18	0.00	0.00
30	1	1.21	75.00	25.00	0.00	0.00
31	2	1.29	63.46	36.54	0.00	0.00
32	1	1.18	82.14	17.86	0.00	0.00
33	1	1.15	85.19	14.81	0.00	0.00
34	1	1.22	74.07	25.93	0.00	0.00
35	1	1.04	82.14	17.86	0.00	0.00

A mean PII=2.0 was observed at 15 years of age and maintained throughout the decades to follow.

Gingival index scores were also very similar for the 3 groups, although there may have been a tendency for the rapid progressing (RP) group to score higher between 15 and 25 years than the other two disease categories. Certainly, for the 30 years and older age groups no difference in gingival index scores could be discerned.

Gingival caries was almost non-existent both for mesial and buccal tooth surfaces. All three groups of individuals scored zero caries in 98-99 of the tooth surfaces. In the few instances gingival caries occurred it was equally often located above, at, or below the gingival margin.

Supra- and subgingival calculus was seen in all 3 subpopulations. The RP group showed clearly the highest rate of calculus formation before 20 years of age, at which time more than 90% of the tooth surfaces developed supra- and subgingival calculus. In comparing the three groups age by age (Fig. 9), the RP group showed the highest mean calculus index and the highest frequency of scores CI=2 or 3. However, the NP group also exhibited calculus formation early in life. By 15 years of age supra-

and subgingival calculus occurred in 36% of the interproximal surfaces. The percent of involved surfaces increased steadily throughout the twenties and thirties, but never reached the levels exhibited by the RP and MP groups.

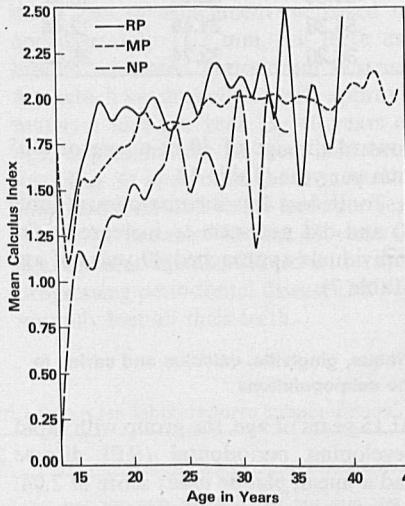


Fig. 9. Mean calculus index - Sri Lanka (mesial root surfaces for all valid observations). Mittlerer Zahnsteinindex - Sri Lanka. (Mesiale Wurzeloberflächen bei allgemeingültigen Beobachtungen). Indice de tartre moyen à Sri Lanka (surfaces radiculaires mésiales pour toutes les observations valables).

Discussion

This study was designed to characterize the initiation and progress of periodontal disease during major portions of man's life (Løe et al. 1978a). The present report describes on the basis of repeated examinations, the development of periodontal disease from the early lesion confined to the marginal gingiva, through the various stages of periodontal destructions, to the ultimate loss of teeth before 45 years of age.

An important feature of this investigation is that the study population at no time during their 45 years of life received any type of dental treatment or made any conscious effort to prevent or intervene with the development of the disease. Furthermore, the homogeneity of the group as regards ethnicity, environment, education and nutrition (Løe et al. 1978a), suggests that special credence be given to any major differences in disease characteristics and disease correlates within the group. Also, the fact that in this particular population dental caries was virtually non-existent, substantially facilitated the analyses, and especially the assessment of the role of periodontal disease in tooth mortality in this population.

In general, this report extends and expands on the longitudinal data reported earlier (Løe et al. 1978a, b, c) and confirms the concept that in the absence of any intervention the loss of periodontal attachment is continuous, and that given time, the progressive destruction of the periodontium will lead to exfoliation of the teeth. However, a significant finding of this study is that even under identical extraneous circumstances, this population exhibited wide ranges of severity of this disease.

It is a matter of record (Anerud et al. 1979) that all 15-year-olds exhibited gingivitis and that both the frequency and severity of the gingival lesion increased before and after the age of twenty. By 30 years of age almost all interdental areas exhibited a degree of gingivitis which was characterized by the major symptoms of chronic inflammation, including bleeding on probing (Løe & Silness 1963). At 15 years of age, almost all participants showed some degree of attachment loss which increased steadily before and after the age of 20. Two distinctly different subpopulations were identified on the basis of the rates of attachment loss and tooth mortality: (1) one showing a rapidly progressing

destruction of the periodontium (RP), and (2) the other exhibiting a relatively moderate progression of the disease (MP).

Rapidly progressing periodontal disease may start before or after the age of 15 years. It may be confined to the first molars and incisors during the early stages, but soon includes all groups of teeth (Fig. 5). The main characteristic of this form of periodontal disease is the rate of destruction. The mean annual rate of attachment loss at 15 years of age (0.13 mm) was relatively low and must be ascribed to the fact that relatively few teeth are involved. As the subjects pass the age of twenty, the rate with which periodontal attachment is lost, had quadrupled (0.5 mm per year). As this subpopulation approached 30 years of age, the mean rate of attachment loss had increased to approximately 1 mm per year.

Tooth loss followed a similar pattern, as very few teeth were lost before the age of twenty (Fig. 4). However, at 20 years and beyond, tooth mortality increased dramatically, so that between 25 and 30 years of age the rate of tooth mortality was approximately 1.5 teeth per year. Between 35 and 40 years of age, the rate of tooth loss increased to 2.3 teeth per year; and as this subpopulation approached 40 years of age essentially all teeth were lost. Approximately 10% of the plantation group exhibited rapidly progressing periodontal disease.

Moderately progressing periodontal disease occurred in more than 80% of the tea laborers. It started before 20 years of age and as in the rapidly progressing disease group, the first signs of periodontal destruction are found in the first molars and the incisors. From 15 to 25 years of age, the lesions progress at a fairly even pace of 0.05–1.0 mm per year. As these individuals approach 30 years all teeth are involved and the rate increases to 0.3 mm per year. Between 30 and 40 years of age the annual rate of attachment loss is again approximately 0.1 mm. The acceleration in loss of attachment during the late twenties confirms the earlier observation (Löe et al. 1978c) that the rate of progression does increase between 25 and 30 years. It is worth noting that this increase coincided with a doubling of the rate of attachment loss in the group exhibiting rapid progression of the disease (RP). At this time, however, we can offer no explanation for this change in the disease rate in either population.

As already commented on, the initiation of the periodontal lesion in the different areas of the dentition may occur at different age levels. Also, the rate of progress of the disease clearly varies between group of individuals, within the individual dentition as well as at different age levels, as shown in these studies. However, under natural conditions, in the absence of any intervention and irrespective of variations in pace and patterns, the periodontal lesion progresses steadily over time. "There may be periods of slow progress and periods in which the destructive processes show acceleration" (Löe et al. 1978c), but as documented in both the rapidly and moderately progressing disease groups, the advancement of the lesions will continue until the entire periodontium is included and will lead to the loss of the tooth, of multiple teeth or the entire dentition.

It should be emphasized that such a steady, continuous progression of the periodontal lesion over a lifetime does not rule out discrete episodes of local exacerbation as possible mechanism of disease progress (Socransky et al. 1984). Linear decay or linear increase in severity are rare phenomena in any chronic disease such as rheumatoid and osteoarthritis, multiple and lateral sclerosis, arteriosclerosis, glaucoma, etc. The fact remains, however, that over time, in the absence of any interference and irrespective of possible short periods of activity and inactivity, periodontal disease in man shows continuous progress.

Perhaps the finding of a small group (10%) of Sri Lankan tea laborers, participating in both the longitudinal and cross-sectional studies who showed essentially no progress of the periodontal disease beyond the gingival lesion, was the most significant result of the present study. The mere presence of such a group among a population who generally exhibits various degrees of rampant periodontal disease, is surprising and intriguing, and will be subject to future study.

Zusammenfassung

Der natürliche Verlauf der menschlichen Parodontalkrankheit. Rapider, mässiger und kein Attachmentverlust bei Arbeitern im Alter von 14–46 Jahren in Sri Lanka

Diese Veröffentlichung beschreibt den Beginn, die Stärke der Progressivität und den dann folgenden Zahnverlust bei einer Bevölkerungsgruppe, die niemals in den Genuss

von zahnheilkundlichen Präventions- und Behandlungsprogrammen gekommen ist. Diese Gruppe bestand aus 480 männlichen Arbeitern von 2 Teeplantagen in Sri Lanka. Die Organisation der Studie und die Ausgangsdaten sind bereits veröffentlicht worden. Bei der Ausgangsuntersuchung im Jahre 1970 waren die Probanden zwischen 14 und 31 Jahre alt. Die dann folgenden Untersuchungen wurden in den Jahren 1971, 1973, 1977, 1982 und 1985 vorgenommen. Die Gesamtstudie deckt also eine Altersstreuung von 14–46 Jahren. Während der Gesamtstudie wurden die klinischen Indizes von den gleichen 2 Untersuchenden registriert, beide gut ausgebildete und erfahrene Parodontologen. Die zwischen den Untersuchenden vorliegende Wiederholbarkeit einer jeden Indexregistrierung wurde bei der Ausgangsuntersuchung getestet und während der Untersuchung von Zeit zu Zeit wiederholt. Die registrierten Daten wurden im Dator erfasst und laufend geordnet. Bei der letzten Untersuchung im Jahre 1985 waren von der ursprünglichen Gruppe 161 Probanden vorhanden, die bereits an der ersten Untersuchung teilgenommen hatten.

Bei dieser Population kam keine konventionelle orale Hygiene vor. Dicker Plaquebelag, reichlicher Zahnstein und Zahnverfärbungen waren die Regel. Sogar wie alle Zahnfleischregionen waren entzündet. Von approximalem Attachmentverlust und der Zahnmortalität ausgehend, wurden 3 Untergruppen identifiziert: (1) Probanden (~8%) mit Zeichen rapider Progression der parodontalen Krankheit (RP), (2) solche (~81%) mit mässiger Progression (MP) und eine Gruppe (~11%) bei der über die Zahnfleischentzündung hinaus keinerlei Progression (NP) der parodontalen Krankheit vorkam.

Im Alter von 35 Jahren war der mittlere Attachmentverlust in der RP-Gruppe ~9 mm, bei der MP-Gruppe lag ein Verlust von ~4 mm vor und bei der NP-Gruppe war der Attachmentverlust geringer als 1 mm. Im Alter von 45 Jahren war der mittlere Attachmentverlust in der RP-Gruppe ~13 mm und in der MP-Gruppe ~7 mm. Die jährliche Destruktionsquote in der RP-Gruppe variierte zwischen 0,1 und 1,0 mm, in der MP-Gruppe zwischen 0,05 und 0,5 mm und in der NP-Gruppe zwischen 0,05 und 0,09 mm. Da nun diese Population praktisch kariesfrei war, kam es nur durch Parodontopathien zu Zahnverlusten. In der RP-Gruppe kam Zahnverlust bereits im Alter von 20 Jahren vor, der dann während der darauf folgenden 25 Jahre weiter anstieg. Im Alter von 35 Jahren waren 12 Zähne verloren gegangen, im Alter von 40 Jahren 20 und mit 45 Jahren war der Zahnverlust total. In der MP-Gruppe begann die Zahnmortalität erst nach dem Erreichen des 30. Lebensjahres und stieg dann während des folgenden Jahrzehntes an. Im Alter von 45 Jahren betrug der mittlere Zahnverlust in dieser Gruppe 7 Zähne. In der NP-Gruppe kam praktisch kein Zahnverlust vor.

Résumé

Histoire naturelle de la maladie parodontale chez l'homme. Perte d'attache rapide, modérée ou absente chez des travailleurs sri lankais âgés de 14 à 46 ans

Cet article décrit le début et le taux de progression de la maladie parodontale et la perte dentaire subséquente dans une population qui n'a jamais été exposée à aucun programme ou aucun incident relatif à la prévention ou au traitement des maladies dentaires. Ce groupe consiste en 480 hommes travaillant dans deux plantations de thé de Sri Lanka. Le type d'étude et les données initiales ont été publiés. Lors de l'examen initial en 1970, l'âge des participants variait entre 14 et 31 ans. Des examens subséquents ont eu lieu en 1971, 1973, 1977, 1982 et 1985. Cette étude englobe donc les groupes d'âge entre 14 et 46 ans. Durant l'étude les indices cliniques ont été établis par les deux mêmes examinateurs, tous deux parodontologues bien entraînés. La variation individuelle pour chaque indice a été testée lors de l'examen initial et répétée périodiquement durant l'étude. Les données pour chaque examen ont été traitées par ordinateur et mises à jour de manière suivie. Au dernier examen, en 1985, 161 individus qui avaient participé à l'examen initial faisaient encore partie de l'étude.

Cette population n'avait accompli aucune mesure d'hygiène buccale conventionnelle et par conséquent avait beaucoup de plaque, de tartre et de coloration dentaire. Pratiquement toute la gencive était enflammée. Basées sur la perte d'attache interproximale et sur les taux de mortalité dentaire, trois sous-populations ont été identifiées: 1) les individus (environ 8%) avec progression rapide de la maladie parodontale (RP), ceux (environ 81%)

avec progression modérée (MP), et un groupe (environ 11%) qui ne montrait aucune progression de la maladie parodontale malgré la présence de gingivite (NP).

À 35 ans, la moyenne de perte d'attache dans le groupe RP était d'environ 9 mm, le groupe MP avait environ 4 mm et le groupe NP moins de 1 mm de perte d'attache. À 45 ans, la moyenne de perte d'attache dans le groupe RP était d'environ 13 mm, et de 7 mm dans le groupe MP. Le taux annuel de destruction dans le groupe RP variait entre 0, 1 et 1,0 mm, dans le groupe MP entre 0,05

et 0,5 mm, et dans le groupe NP entre 0,05 et 0,09 mm. Puisque cette population n'a pratiquement pas de caries toutes les pertes dentaires sont dues à la maladie parodontale. Dans le groupe RP la perte dentaire apparaissait déjà à 20 ans et augmentait pendant les 25 années suivantes. À 35 ans 12 dents manquaient, à 40 ans 20, et à 45 ans toutes. Dans le groupe MP, la mortalité dentaire commençait après 30 ans et augmentait pendant la décennie suivante; à 45 ans la moyenne de perte dentaire y était de 7 dents. Le groupe NP n'avait quasi aucune perte dentaire.

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