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The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults

Results after 30 years of maintenance

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Abstract

Background: The biofilm that forms and remains on tooth surfaces is the main etiological factor in caries and periodontal disease. Prevention of caries and periodontal disease must be based on means that counteract this bacterial plaque.

Objective: To monitor the incidence of tooth loss, caries and attachment loss during a 30-year period in a group of adults who maintained a carefully managed plaque control program. In addition, a comparison was made regarding the oral health status of individuals who, in 1972 and 2002, were 51–65 years old.

Material and Methods: In 1971 and 1972, more than 550 subjects were recruited. Three hundred and seventy-five subjects formed a test group and 180 a control group. After 6 years of monitoring, the control group was discontinued but the participants in the test group was maintained in the preventive program and was finally re-examined after 30 years. The following variables were studied at Baseline and after 3, 6, 15 and 30 years: plaque, caries, probing pocket depth, probing attachment level and CPITN. Each patient was given a detailed case presentation and education in self-diagnosis. Once every 2 months during the first 2 years, once every 3–12 months during years 3–30, the participants received, on an individual need basis, additional education in self-diagnosis and self-care focused on proper plaque control measures, including the use of toothbrushes and interdental cleaning devices (brush, dental tape, toothpick). The prophylactic sessions that were handled by a dental hygienist also included (i) plaque disclosure and (ii) professional mechanical tooth cleaning including the use of a fluoride-containing dentifrice/paste.

Results: Few teeth were lost during the 30 years of maintenance; 0.4–1.8 in different age cohorts. The main reason for tooth loss was root fracture; only 21 teeth were lost because of progressive periodontitis or caries. The mean number of new caries lesions was 1.2, 1.7 and 2.1 in the three groups. About 80% of the lesions were classified as recurrent caries. Most sites, buccal sites being the exception, exhibited no sign of attachment loss. Further, on approximal surfaces there was some gain of attachment between 1972 and 2002 in all age groups.

Conclusion: The present study reported on the 30-year outcome of preventive dental treatment in a group of carefully monitored subjects who on a regular basis were encouraged, but also enjoyed and recognized the benefit of, maintaining a high standard of oral hygiene. The incidence of caries and periodontal disease as well as tooth mortality in this subject sample was very small. Since all preventive and treatment efforts during the 30 years were delivered in one private dental office, caution must be exercised when comparisons are made with longitudinal studies that present oral disease data from randomly selected subject samples.

Key words: caries; longitudinal study; periodontal disease; tooth mortality

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At the time this prospective study was initiated (1971–1972) it was recognized that bacteria present in the microbial plaque were associated with both caries and periodontal disease.

In a landmark publication, Orland et al. (1954) had demonstrated that rats reared under germ-free conditions remained entirely free of dental caries even when fed with a sugar-rich diet.

Conventional rats possessing ''the usual mixed microbial populations''- …on the other hand, ''developed caries lesions when maintained on the same dietary regime as the germfree animals''. These findings were subsequently confirmed in experiments using a hamster model (Fitzgerald & Keyes 1960) as well as in clinical studies in man by von der Fehr et al. (1970) and Löe et al. (1972). Von der Fehr et al. (1970) demonstrated that human volunteers who refrained from mechanical tooth cleaning but rinsed nine times a day with a 50% sucrose solution developed caries lesions within a 3-week period. When the panelists rinsed under identical conditions, twice a day, with a 0.2% solution of chlorhexidine digluconate, however, plaque formation was prevented and no caries lesions formed (Löe et al. 1972).

Findings from epidemiological studies (reviewed by Scherp 1964) had documented that there was a strong correlation between age, oral hygiene (OHI; Greene & Vermillion 1960) and periodontal disease (PI; Russel 1956). Indeed, it was concluded that ''residual factors wholly independent of age and oral hygiene… would be expected to have little effect on periodontal disease as scored by PI…''

In a study presented by the Waerhaug group (Lövdal et al. 1961) attempts were made to improve the periodontal conditions of a large group (>800 subjects) of adults (20–59 years) who were employees of a factory in Oslo, Norway, by improving their oral hygiene conditions. This was accomplished through meticulous instruction in tooth brushing and in interdental cleaning with toothpicks plus supra- and subgingival scaling. Thus, over a 5-year period all subjects were recalled, 2–4 times per year, for evaluation of their oral hygiene and reinstruction plus non-surgical therapy. The authors reported that through this supportive periodontal therapy (i) the gingival conditions improved by about 60% and (ii) the loss of teeth was only 50% of the estimated tooth mortality. A study with a similar outline was reported by Suomi et al. (1971). Two groups of young adults with gingivitis and minor loss of periodontal attachment were monitored for 3 years. One group of subjects received education in oral hygiene and professional scaling once every 3 months while for the second group no treatment was provided. The authors observed that in the test group plaque and gingivitis were significantly reduced and the mean amount of probing attachment loss was only 0.08 mm/site, while in the control group the corresponding attachment loss amounted to 0.3 mm.

In 1965, Löe et al. had published their important study on ''Experimental gingivitis in man''. Human volunteers who abstained from tooth cleaning formed plaque and developed clinical signs of gingivitis within a 3-week period. When oral hygiene efforts were resumed and plaque removed, the inflammatory lesions in the gingival were resolved. Saxe et al. (1967) in a beagle dog experiment had demonstrated that while portions of the dentition that were regularly exposed to mechanical debridement remained healthy, contralateral sites that were not cleaned exhibited signs of periodontal tissue breakdown.

Taken together, the information summarized above prompted us to initiate a series of studies in the early 1970s in children and adults the objectives of which were to prevent or retard the development of caries and gingivitis/periodontitis through the use of plaque control methods. The outcome of these attempts was presented in publications by Axelsson & Lindhe (1974, 1977, 1978, 1981a–c, 1987) and Axelsson et al. (1976, 1991).

The current publication represents the final report in this series and describes the incidence of tooth loss, caries and attachment loss during a 30-year-period in a group of adults that were recruited for the preventive program in 1971–1972. In addition, a comparison is made regarding the oral health status of individuals who in 1972 and 2002 were 51–65 years old.

Material and Methods

In the Fall of 1971 and Spring of 1972 more than 550 subjects were recruited for a study aimed at assessing the long-term effect of a preventive program based on professional and self-performed plaque control measures on caries, periodontal disease and tooth loss. Three hundred and seventy-five subjects formed a test group and 180 a control group. For details regarding the original subject sample, the reader is referred to previous publications by Axelsson & Lindhe (1978, 1981a) and Axelsson et al. (1991). After 6 years of monitoring, the control group was discontinued but the participants in the test group was maintained in the preventive program and was finally re-examined after 30 years.

Variables

At the baseline and the comprehensive re-examinations, the following variables were studied on all available teeth, except third molars:

Plaque

The teeth were stained with a disclosing solution and the presence or absence of plaque was determined on approximal, buccal and lingual/palatal surfaces.

Caries

Clinical, radiographic and recurrent caries lesions were identified according to criteria by Koch (1967). Each surface was recorded as either healthy, decayed or filled (DF) or missing (M).

Gingivitis

Sites (approximal, buccal and lingual/palatal) that bled on gentle pocket probing were regarded as inflamed and identified as BoP+.

Probing pocket depth (PPD)

PPD was measured with a graduated periodontal probe (Hu-Friedy® Manufacturing Co., Chicago, IL, USA) to the nearest mm at approximal, buccal and lingual/palatal surfaces.

Probing attachment level (PAL)

PAL was measured with the probe as the longest distance between the cemento-enamel junction and the base of the probable pocket at approximal, buccal and lingual/palatal surfaces.

CPITN (Ainamo et al. 1982)

The clinical variables describing the periodontal status of a given tooth site were translated into a CPITN score characteristic of this particular site.

Treatment

Following the baseline examination carious lesions were treated, faulty restorations adjusted and each subject was given non-surgical periodontal therapy.

Preventive program

Each patient was given a detailed case presentation and education in self-diagnosis and self-care. Once every 2 months during the first 2 years and once every 3 months during years 3–6, the participants received, on an individual need basis, additional education in self-diagnosis and self-care focused on proper plaque control measures, including the use of toothbrushes and interdental cleaning devices (brush, dental tape, toothpick). The prophylactic sessions that were handled by a dental hygienist (BN) also included (i) plaque disclosure and (ii) professional mechanical tooth cleaning (PMTC), including the use of a fluoride containing dentifrice/paste. For details regarding the preventive sessions, see Axelsson & Lindhe (1978).

Based on the results obtained after 6 years regarding the incidence of caries and periodontal disease progression, the subjects in the test group were stratified into three subgroups, risk groups (R 1, R 2 and R 3) according to estimated risk for additional disease. They were then recalled in ''need-related'' intervals; group R 1(60% of subjects): once every 12 months; group R 2 (30% of subjects): once every 6 months; and group R 3 (10% of subjects): every 3 months.

Re-examinations

Examinations regarding caries, gingivitis and PPD were performed once a year by a dentist (PA) but comprehensive re-examinations including all baseline variables were performed after 3, 6, 15 and 30 years by a dentist (PA) and a dental hygienist (BN) working together.

Results

Sample

In 1972 the 375 participants in the test group (Table 1) were divided into three age categories; 20–35 year old (group 1), 36–50 year olds (group 2) and 51–65 year olds (group 3). During the initial 15-year interval 58 and in the second 15-year interval another 60 subjects were lost. Group 1 exhibited the smallest (about 20%) and group 3 the largest (about 70%) number of subjects that discontinued participation. The various reasons for dropout are listed in Table 2. In all, 49 of the original participants died, 61 moved to other parts of Scandinavia and finally eight discontinued their participation because their interest in dental disease prevention vanished. The data reported in tables and diagrams include only findings from subjects that were available at all examinations.

Number of teeth

Table 3 presents the number of remaining teeth in the three age groups at baseline and at the re-examination after 30 years. In 1972, the 20–35- and the 36–50-year-olds had about 26 remaining teeth while the corresponding number in the oldest age group (group 3) was about 20. In the interval between 1972 and 2002, there was an additional small number of teeth that were lost: 0.4 and 0.7 in groups 1 and 2 and 1.8 in group 3. The calculated annual rates of tooth loss for the entire 30-year period were 0.01, 0.02 and 0.06 for the three age categories.

Fig. 1 reports the number of teeth present in subjects who in year 1972 and in year 2002 were 51–65 years of age, i.e. group 3 in the 1972 sample and group 1 in the year 2002 sample. In 1972, about 60% of the subjects in this age group had on average $\geqslant 20$ remaining teeth and about 20% $\geqslant 26$ teeth; the corresponding frequencies in 2002 was $\geqslant 95\%$ and $\geqslant 65\%$.

The bar chart in Fig. 2 illustrates that all categories of remaining teeth (incisiors, canines, premolars and molars) in the maxilla, as well as in the mandible, were more abundant in the 2002 than in the 1972 sample. The greatest relative increase occurred in first and second molars.

During the 30-year interval, 29 incisors (in 19 subjects), 58 premolars (in 44 subjects) and 86 molars (in 67 subjects) were lost (Table 4) for a variety of reasons (Table 5), such as *root fracture* (108), *root resorption* (12), *caries* (12), *trauma* (8), advanced *periodontal* (9) and *endodontal* (24) *disease.*

Plaque

At the baseline examination about 50–60% of all tooth surfaces in the three age groups exhibited the presence of plaque (Fig. 3). A larger number of approximal tooth surfaces ($>80\%$) harbored plaque than corresponding lingual ($<70\%$) and buccal ($<25\%$) surfaces. In 2002, the overall plaque scores were low ($<20\%$) in all 3 groups. Buccal surfaces were almost devoid of plaque while about 20% of the approximal surfaces harbored varying amounts of microbial deposits.

Table 1. Number of subjects in the three age groups

	Age (1972) (years)	1972	1987	2002
Group 1	20–35	156	137	133
Group 2	36–50	134	116	100
Group 3	51–65	85	64	24
All		375	317	257

Table 2. Reasons for ''dropout''

Group	Died	Moved	Lack of interest	Total
1	2	19	2	23
2	7	24	3	34
3	40	18	3	61
All	49	61	8	118

Table 3. Mean number of teeth present and calculated annual loss of teeth

Group	1972	2002	Difference	Annual rate of tooth loss
1	26.7	26.3	0.4	0.01
2	25.8	25.1	0.7	0.02
3	20.1	18.3	1.8	0.06

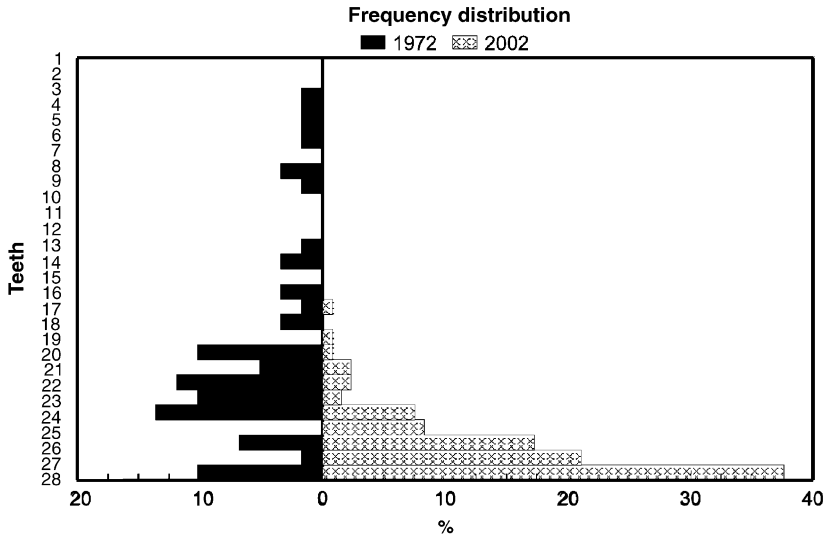

Fig. 1. Frequency distribution of remaining teeth in 51–65-year-old subjects in 1972 compared to 2002.

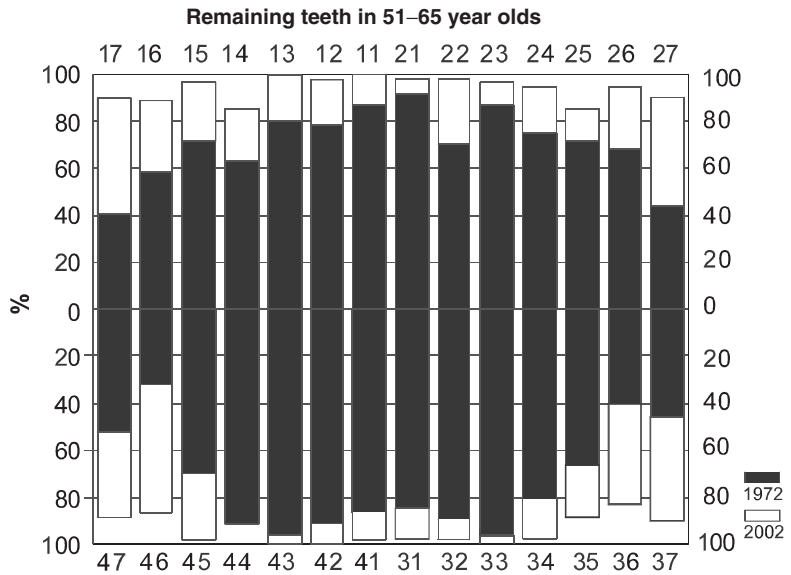

Fig. 2. Mean percentage of remaining individual teeth (Federation Dentaire Internationale (FDI) tooth-numbering system) in 51–65-year-old subjects in 1972 compared to 2002.

Table 4. Number of teeth that were lost and number of ''looser'' subjects in the different age groups

Group	Incisors							Premolars					Molars			
	0	1	2	3	4	5	6	0	1	2	3	4	0	1	2	3
Group 1 ($n = 133$)	127	3	3					120	10	3			107	20	5	1
Group 2 ($n = 100$)	92	8						80	16	4			69	24	5	2
Group 3 ($n = 24$)	19	2	2				1	13	8	1		2	14	7	3	
All subjects ($n = 257$)	238	13	5				1	213	34	8		2	190	51	13	3

Caries

The mean number of new DS in the 3 age groups varied after 6 years between 0.2 and 0.3, after 15 years between 0.7 (group 1) and 1.0 (groups 2 and 3), and after 30 years between 1.2 (group 1), 1.7 (group 2) and 2.1 (group 3). Out of 257 subjects, 107 developed no new DS and only 10 subjects exhibited an incidence of >6 decayed surfaces (Fig. 4). In all three groups, the majority of the participants exhibited no or only one new caries lesion during the 30 years of maintenance.

Fig. 5 presents the DMFS scores for subjects that were in the 51–65 year age category in 1972 and in 2002. In 1972, the percentage of intact (healthy) surfaces was about 35% and the percentage of missing surfaces $>25\%$. The corresponding numbers in year 2002 were 55% healthy and 5% missing. Thus, at both examinations the percentage of DF (decayed or filled) surfaces was about 40%.

The improvement of the dental health that had occurred in the 30-year interval is also illustrated by findings described in Fig. 6. The bar chart reports the percentage of subjects in the 51–65 year age category that exhibited different numbers of intact tooth surfaces. It is obvious that the 30 years of preventive dental care and oral health education had resulted in a marked increase in subjects that presented with a large number of sound tooth surfaces. Thus, in 1972 about 80% of the subject sample had $\leqslant 50$ sound tooth surfaces while in 2002 more than 40% of subjects had >70 healthy surfaces.

CPITN

The CPITN scores for the three age groups and examination intervals are described in Table 6. The overall mean data indicated that in 1972 about 27% of all sites were in need of varying amounts of periodontal therapy (scores 2, 3 and 4). The corresponding figure for 2002 was 1%. This improvement of the periodontal conditions between baseline and the re-examination after 30 years was similar in all three age groups studied.

The frequency distribution of different CPITN scores for 51–65 year olds in 1972 and 2002 is presented in Fig. 7. In 1972, the subjects in this age group had a low frequency (10%) of healthy units (score 0). About 40% of sites were in need of improved self-care, 20% required professional treatment (scores 2, 3 and 4) and 30% of sites were missing. After 30 years of preventive therapy, the 51–65-year-old subjects exhibited a high percentage ($>90\%$) of healthy periodontal sites, $<5\%$ were in need of addition self-care and 5% of sites were missing.

Table 5. Reasons for teeth that were lost between 1972 and 2002 in the 257 subjects that returned for the 30-year follow-up examination

Reason	Root fracture	Root resorption	Caries	Trauma	Perio	Endo	All
Group 1 ($n = 133$)	31	6	4	6	2	9	58
Group 2 ($n = 100$)	49	4	3	2	4	10	72
Group 3 ($n = 24$)	28	2	5	0	3	5	43
All subjects ($n = 257$)	108	12	12	8	9	24	173

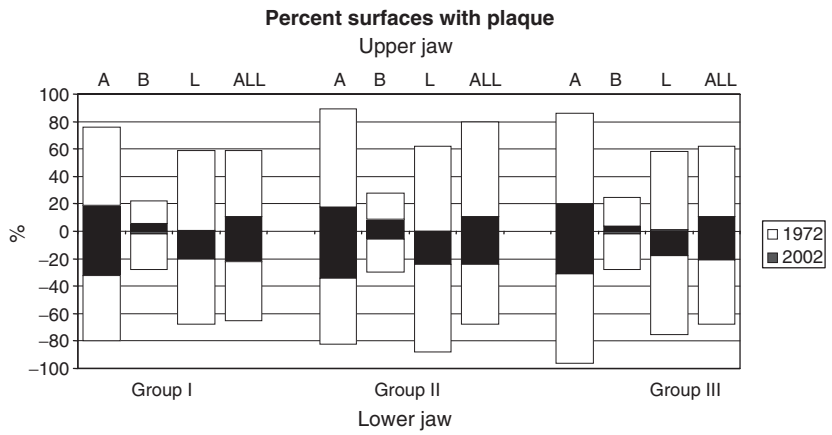

Fig. 3. Percentage of disclosed plaque on approximal (A), buccal (B), lingual (L) and mean values for (all) tooth surfaces in the maxilla and mandible in 1972 and 2002 in age groups 1–3.

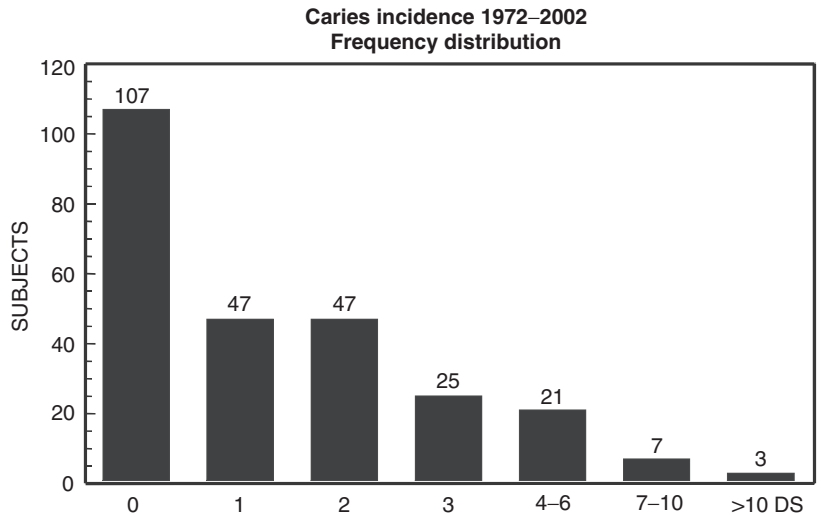

Fig. 4. Frequency distribution of new decayed surfaces (DS) between 1972 and 2002.

PAL

The mean values that describe PAL change for mesial, buccal and lingual sites in groups 1–3 after 6, 15 and 30 years of preventive care are reported in Table 7. At mesial and lingual sites there was in all age groups a small gain in PAL that amounted to between 0.3–0.5 mm (mesial sites) and 0.1 – 0.2 mm (lingual sites). At buccal surfaces in group 1, a small loss of PAL (0.2 mm) had occurred between 1972 and 2002.

Further, during the 30-year interval a certain percentage of sites (2–4%) in all three age groups exhibited PAL loss of $\geqslant 2$ mm. In general, this amount of attachment loss was more frequent in the mandible (5–6%) than in the maxilla (2–3%) and occurred in groups 1 and 3 more often at buccal (5–6%) than at lingual/palatal (2%) sites.

The frequency of approximal (mesial) sites that exhibited varying amounts of probing attachment loss in subjects that belonged to the 51–65 year age group in 1972 and 2002 is presented in Fig. 8. In 1972, about 50% of sites exhibited a probing attachment loss of $\geqslant 3$ mm and about 20% of sites a loss of $\geqslant 4$ mm. In subjects who in year 2002 were 51–65 years of age, more than 95% of sites exhibited no or only minor probing attachment loss and $< 1\%$ of sites had lost $\geqslant 4$ mm attachment. Table 8 describes the percentage of subjects that had a mean PAL value (mesial sites) of 0–1 mm, 1.1–2.5 mm and $\geqslant 2.5$ mm. Both in 1972 and in 2002 about 42–45% of the subjects were within the 1.1–2.5 mm PAL category. However, while in 2002 as many as 50.4% of all subjects were found in the 0–1 mm group, in 1972 as many as 57.6% had a PAL value of > 2.5 mm. The improved periodontal conditions are also illustrated in Fig. 9, which describes the mean PAL at mesial surfaces of molars, premolars and incisors in 1972 and in 2002 for subjects in the 51–65 year age category. For all teeth in both the maxilla and the mandible, the mean PAL value was about 1–1.5 mm higher in the 1972 than in the 2002 sample.

Discussion

The present study reports the 30-year outcome of preventive dental treatment in a group of carefully monitored subjects that on a regular basis were encouraged, but also enjoyed and recognized the benefit of, maintaining a high standard of oral hygiene. Since all preventive and treatment efforts during the final 24 years were delivered in one private dental office, caution must be exercised when comparisons are made with longitudinal studies that present data on tooth mortality, caries and periodontitis in randomly selected subject samples.

Subjects sample

About 70% of the subjects that were examined at baseline returned for the 30-year follow-up examination. In groups 1 and 2, as many as 84% and 75% of the participants remained in the study while in group 3 only 28% returned for the final examination. In this context it should be realized that in 1972, the participants in group 3 were > 50 years

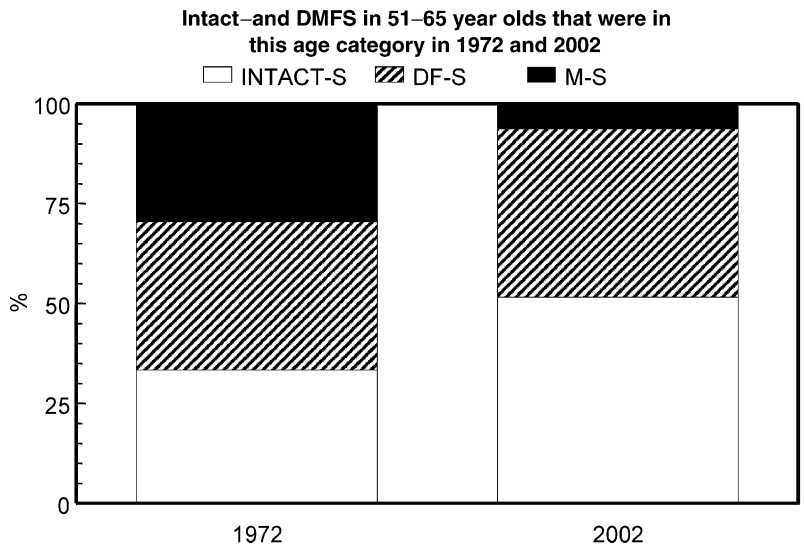

Fig. 5. Percentage of intact surfaces, (Intact-S), decayed and filled surfaces (DFS) and missing surfaces (MS) in 51–65-year-old subjects in 1972 compared to 2002.

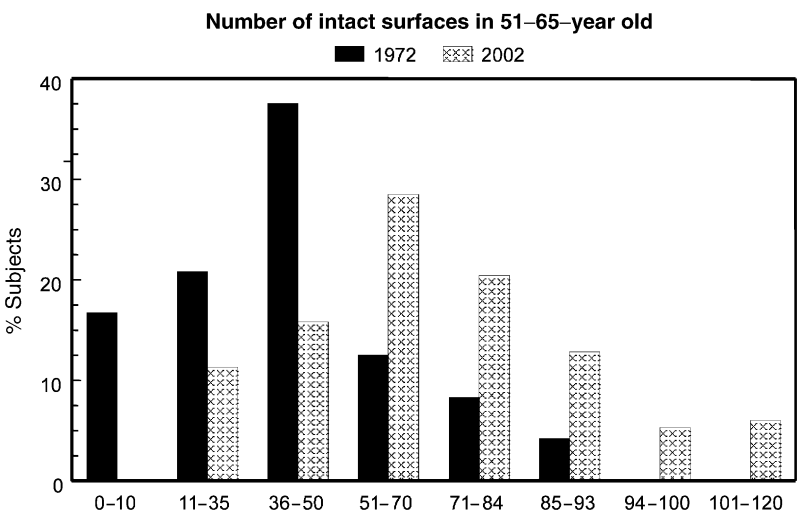

Fig. 6. Frequency distribution of 51–65-year-old subjects with varying numbers of intact tooth surfaces in 1972 and in 2002.

Table 6. Frequency distribution of sites with different CPITN scores in the three age groups in 1972 and 2002

Score (%)	Group 1		Group 2		Group 3		All	
	1972	2002	1972	2002	1972	2002	1972	2002
0	25	98	24	97	17	98	22	98
1	54	1	51	2	50	1	51	1
2	18	1	20	0	24	0	21	0
3	3	0	5	1	7	1	5	1
4	0	0	0	0	2	0	1	0

of age and during the 30 years of study as many as 40 subjects died; the remaining 24 individuals were 81–95 years of age in 2002.

The estimated number of annual ''dropouts'' in groups 1 and 2 were 0.5% and 0.8% respectively. Only two subjects in groups 1 and three in group 2 were lost because of a reported ''lack of continued interest'' in the preventive program. The number of subjects lost in the current study was lost is small in comparison to data reported from other similar trials; e.g. Lövdal et al. (1961) (Norway) = 8%/year, Suomi et al. (1971) (USA) = 17%/year, Eneroth & Sundberg (1985)(Sweden) = 5%/year and Rosén et al. (1999)(Sweden) = 5%/year. There are reasons to suggest that (i) the repeated motivation delivered at each recall, (ii) the needs-related oral hygiene training at each visit and PMTC guided by plaque disclosure and (iii) regular ''feedback'' from the dentist and hygienist regarding the patients' improvement in oral health status were factors that stimulated the participants to remain in the demanding preventive program.

Tooth mortality

In the current study, only few teeth were lost during the 30 years of maintenance; 0.4 in group 1, 0.7 in group 2 and 1.8 in group 3. The main reason for tooth loss was root fracture in endodontically treated teeth fitted with cast posts or screw posts, and only 21 teeth were lost because of progressive periodontitis or caries. This low incidence of tooth mortality is in agreement with findings by Löe et al. (1978) who monitored the oral health status of well maintained young academicians in Oslo, Norway. The authors reported that during a 6-year interval a mean of 0.24 teeth/subject were lost.

In the current sample, the most frequently lost teeth were maxillary molars and premolars as well as mandibular molars. This finding is in agreement with data from other longitudinal studies (e.g. Hirschfeld & Wasserman 1978, Hunt et al. 1985).

At the baseline examination in 1972, the 51–65-year-old individuals (group 3) had a mean number of 20.1 remaining teeth. In comparison, subjects who in 2002 were 51–65 years of age (group 1) and who during a 30-year period had been enrolled in the needs-related preventive program had an average of 26.3 remaining teeth. In comparison to other study samples (e.g. Miller et al. 1987, Håkansson 1991, Hugoson & Laurell 2000, Jansson et al. 2002, Fure 2003) tooth retention in group 1 was very high and must be ascribed to the patients continued ability to control plaque formation. Indeed, in conjunction with the final examination of the current trial

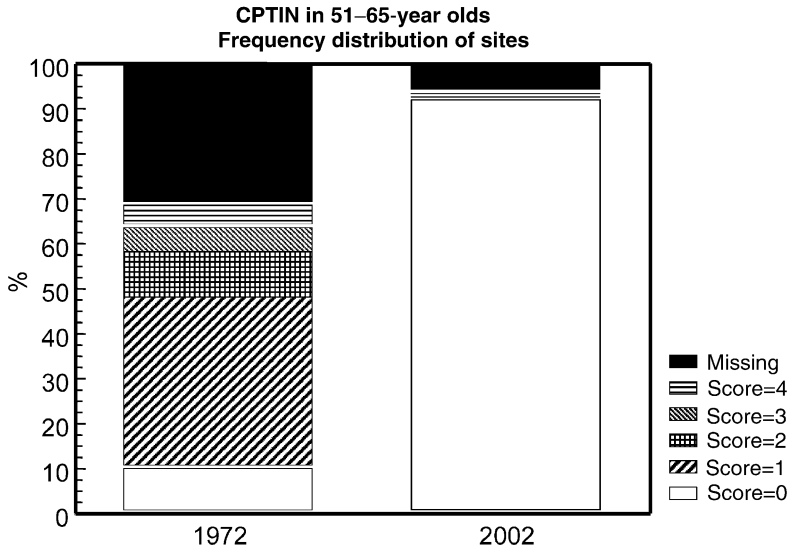

Fig. 7. Frequency distribution of missing sites and sites with CPITN scores 0–4 in 51–65-year-old subjects in 1972 compared to 2002.

Table 7. Mean probing attachment level change that occured between baseline in 1972 and 1978, 1987 and 2002 respectively

	Mesial sites (mm)			Buccal sites (mm)			Lingual sites(mm)		
	1978	1987	2002	1978	1987	2002	1978	1987	2002
Group 1	+0.4	+0.5	+0.3	+ − 0	+ − 0	− 0.2	+0.2	+0.2	+ − 0
Group 2	+0.4	+0.5	+0.4	+0.1	+ − 0	+ − 0	+0.1	+0.2	+ − 0
Group 3	+0.3	+0.4	+0.3	+ − 0	+0.1	+ − 0	+0.1	+0.2	+0.1

+, gain, −, loss.

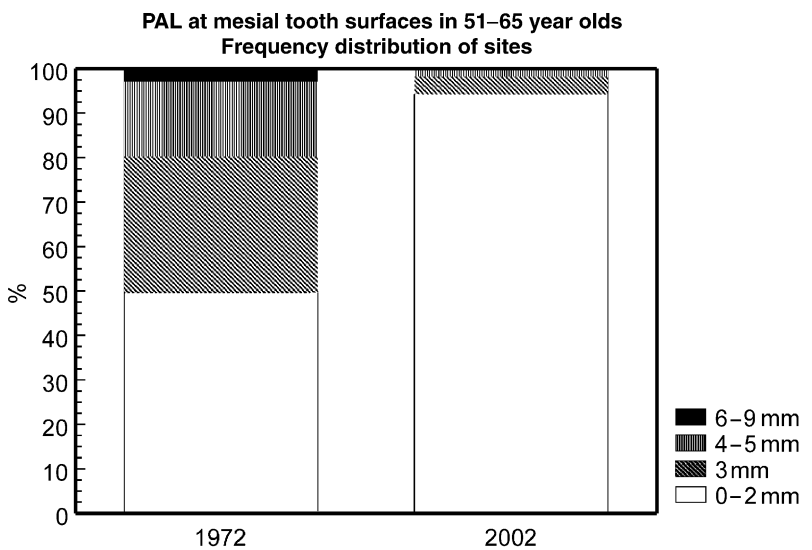

Fig. 8. Frequency distribution of probing attachment levels (0–2, 3, 4–5 and 6–9 mm) (PAL) on mesial sites in 51–65-year-old subjects in 1972 compared to 2002.

the subjects in group 1 reported that they (i) brushed their teeth twice daily (>90%) and (ii) regularly used interdental cleaning devices, such as toothpicks, dental tape, interdental brushes (>80%).

Caries

During the 30-year period a mean number of 1.2, 1.7 and 2.1 new caries lesions occurred in groups 1–3. About 80% of the lesions could be classified as recurrent caries and in groups 2 and 3 between 10% and 20% of the lesions occurred on exposed root surfaces. This low incidence of caries is most likely explained not only by the careful plaque control maintained by the patients but also by the daily use of a fluoridated dentifrice and PMTC at needs-related intervals. Similar findings were presented by Söderholm (1979). In a 3-year pre-experimental period without oral hygiene intervention, a group of 256 individuals developed on the average 0.4 new caries lesions/year on approximal surfaces. During the subsequent 4 years, the subjects were recalled every 3 months for education and training in plaque control means and need-related scaling and root planning. As a result of this preventive regimen, Söderholm (1979) reported that the number of new decayed surfaces was reduced to 0.17/year. In this context it must be realized that Swedish subjects who are not enrolled in preventive programs experience a much higher incidence of caries than carefully maintained patients. Thus, Fure (2003) recently showed that in randomized samples of 55-, 65-, and 75-year-olds from the city of Göteborg, Sweden, the average number of new coronal DF surfaces during a 10-year interval were 6.0, 3.8 and 1.8 while the mean number of root caries lesions in the same period amounted to 5.5, 8.1 and 14.3.

Periodontal disease

It is well established that self-performed plaque control and PMTC combined with needs-related scaling and root planing are effective means of controlling gingivitis and periodontitis (for a review, see Axelsson 1994, 1998). In the current subject sample most sites, buccal surfaces being the exception, exhibited no sign of attachment loss. Further, on approximal surfaces there was in all three age groups a mean gain of PAL between 1972 and 2002 that amounted to between 0.3 and 0.4 mm. These observations are in general agreement with findings by Eneroth & Sundberg (1985) who monitored >900 adult subjects during a 5-year interval. The patients were recalled 6–12 times

Table 8. Mean probing attachment level (PAL) at mesial tooth surfaces in 51–65-year-olds – frequency distribution of subjects that were in this age category in 1972 and in 2002

Mean mesial PAL	0–1 mm	1.1–2.5 mm	> 2.5 mm
% subjects 1972	0	42.4	57.6
% subjects 2002	50.4	45.1	4.5

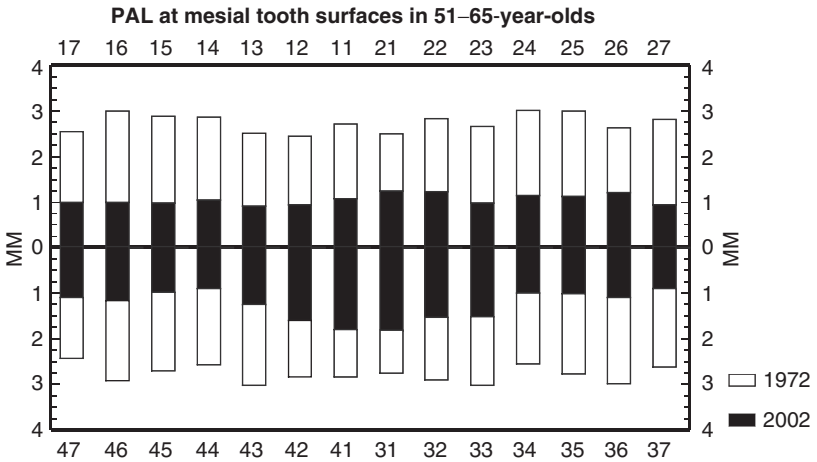

Fig. 9. Mean values describing probing attachment loss (PAL) at the mesial surfaces of all remaining teeth in 51–65-year-old subjects (FDI tooth-numbering system) in 1972 compared to 2002.

per year for oral hygiene education and PMTC provided by specially trained dental assistants. The authors reported that during the 5-year period no additional loss of periodontal attachment had occurred.

In contrast, in two recently published longitudinal studies by Hugoson & Laurell (2000) and Jansson et al. (2002) it was reported that significant amounts of periodontal tissue support (radiographic bone loss) were lost in 47–75-year-old Swedish subjects during a 20-year period. Thus, in these randomized samples the annual loss of periodontal support amounted to 0.1 mm. In a similar 10-year longitudinal study of a randomized sample of 50–70-year-old Chinese subjects, the corresponding mean annual loss of attachment was 0.18 mm (Baelum et al. 1997).

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