On the prevention of caries and periodontal disease

Results of a 15-year longitudinal study in adults


Abstract. In 1971–72, a total of 375 adult subjects were recruited for a clinical trial aimed at assessing the effect of a preventive program, based on plaque control and topical application of fluoride, on the incidence of caries and periodontal disease. During the baseline examination, the volunteers were subjected to scaling, root planing and conventional caries therapy. During the course of the subsequent 6 years, they were recalled for preventive measures once every 2–3 months. After the 6-year follow-up examination, however, it was decided to extend the interval between the preventive sessions. Thus, during the next 9-year period, about 95% of the participants returned for preventive measures only 1 to 2 times per year. A small subgroup of about 15 subjects, who, during the initial 6 years had developed new caries lesions or had exhibited additional periodontal attachment loss, however, were also during the following 9 years recalled 3–6 times per year for oral hygiene control and preventive therapy. The re-examination performed in 1987 disclosed that the 317 subjects, who participated during the entire 15-year period, had a low incidence of caries and almost no further loss of periodontal tissue support. It was suggested that improved self-performed oral hygiene, daily use of fluoridated dentifrice and regularly repeated professional tooth cleaning effectively prevented recurrence of dental disease.

Key words: caries; plaque; gingivitis; periodontitis; prevention; longitudinal study.

Accepted for publication 19 March 1990

Current knowledge regarding the etiology of caries and periodontal disease suggests that these major dental disorders to a large extent may be prevented or markedly arrested by (i) measures directed towards the control of bacterial plaque formation and (ii) by the daily use of fluoride containing dentifrice. Studies by Lövdal et al. (1961), Suomi et al. (1971), Lindhe & Nyman (1975, 1978, 1984), Knowles et al. (1979), Nyman & Lindhe (1979), Söderholm (1979) and others (for review, see Gjermo (1986)) have demonstrated that treatment programs with a preventive emphasis may substantially improve dental health in adults and reduce the need for restorative treatment.

In 1971–72, Axelsson & Lindhe initiated a study aimed at assessing the effect of controlled oral hygiene procedures on caries and periodontal disease in a sample of 375 adults. After a baseline examination including assessments of oral hygiene standards, caries and periodontal disease, the volunteers received oral hygiene instruction, scaling and restorative therapy. During the subsequent 6 years, the subjects were recalled for professional oral prophylaxis (Axelsson & Lindhe 1974) once every 2 to 3 months. After 3 years (Axelsson & Lindhe 1978) and 6 years (Axelsson & Lindhe 1981), the participants were re-examined. It was observed that the preventive program utilized had resolved gingivitis and markedly arrested progression of caries and periodontitis.

After the 6-year examination, it was decided that the participants should be recalled for preventive measures on a customized, “need-related” basis. Thus, during the course of the subsequent 9 years, about 95% of the well-motivated volunteers returned for prophylaxis only once or twice a year. The present report describes the incidence of caries and periodontal disease in the subjects who remained enrolled in the preventive program during the entire 15-year period.

Material and Methods

In 1971–1972, subjects were recruited for a clinical trial aimed at assessing the effect on caries and periodontal disease of a preventive program based on measures to control the formation of dental plaque. 375 subjects were assigned to a test group and 180 to a control group. For details regarding the subject sample see Axelsson & Lindhe (1978).

At the baseline examination (1971–1972), all available teeth, except third molars, and all mesial, distal, buccal and lingual surfaces and units were examined with respect to oral hygiene status, dental caries, gingivitis, and periodontal pockets. Probing attachment levels were assessed on buccal, lingual and mesial surfaces. The following parameters were studied.

Oral hygiene status

The teeth were stained with a disclosing solution containing 4% erethosine. The presence of a continuous band of stained material (plaque) in the cervical portion of the tooth surface was determined. For each individual, the % of surfaces which harbored plaque was calculated.
Table 1. Mean number of new and recurrent carious lesions (D-s and R-s) as well as the overall mean attachment level change that occurred in the test and control groups during the initial 6-year period

<table>
<thead>
<tr>
<th></th>
<th>Test group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-s + R-s</td>
<td>0.2</td>
<td>14.9</td>
</tr>
<tr>
<td>attachment change (mm) gain</td>
<td>0.2</td>
<td>loss</td>
</tr>
<tr>
<td>Age group 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-s + R-s</td>
<td>0.2</td>
<td>15.1</td>
</tr>
<tr>
<td>attachment change (mm) gain</td>
<td>0.2</td>
<td>loss</td>
</tr>
<tr>
<td>Age group 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-s + R-s</td>
<td>0.3</td>
<td>11.9</td>
</tr>
<tr>
<td>attachment change (mm) gain</td>
<td>0.2</td>
<td>loss</td>
</tr>
</tbody>
</table>

Data reported only for the 317 test subjects that continued to participate during the entire 15-year period.

Dental caries

Prior to the clinical examination, a full mouth radiograph and, in addition, 4 bite-wing radiographs were obtained from the lateral segments of the dentition of each subject. The radiographs were available in conjunction with the clinical examination.

Clinical caries, radiographic caries and recurrent caries (Codes 1, 3 and 4) were assessed according to the method described by Koch (1967).

Gingivitis

The % of gingival units which bled on probing to the base of the probeable pocket was determined for each individual.

Probing depth

The depth of the probeable pocket was measured from the gingival margin to the nearest 1 mm with the use of a graduated periodontal probe (Hu-Friedy*).

Probing attachment level

The distance between the CEJ (or another well-defined landmark close to the CEJ) and the base of the probeable pocket was measured to the nearest 1 mm using the periodontal probe.

CPITN

In 1987, the clinical parameters of periodontal disease obtained at the baseline examination as well as at the 15-year follow-up examination were translated into modified CPITN scores (Aimano et al. 1982). Thus, the CPITN value for each individual tooth surface was calculated and the % distribution of the various score values computed.

Treatment

Following the baseline examination, the subjects of the test and control groups received a detailed case presentation. All carious lesions were treated, ill-fitting restorations were adjusted and each participant given a careful dental prophylaxis.

Preventive measures

The subjects in the test and control groups were stratified in 3 age categories: 20–35 year old (group 1), 36–50 (group 2), and 51–70 year old (group 3) individuals.

Table 2. Number of participating subjects in the test group in 1972 and 1987

<table>
<thead>
<tr>
<th>Year</th>
<th>1972</th>
<th>1987</th>
</tr>
</thead>
<tbody>
<tr>
<td>group 1</td>
<td>156</td>
<td>137</td>
</tr>
<tr>
<td>group 2</td>
<td>134</td>
<td>116</td>
</tr>
<tr>
<td>group 3</td>
<td>85</td>
<td>64</td>
</tr>
<tr>
<td>all</td>
<td>375</td>
<td>317</td>
</tr>
</tbody>
</table>

During the first 2 years of the trial, the participants of the test group were recalled for preventive measures once every 2 months, while during the subsequent 4 years, the recall interval was 3 months.

Each preventive session included: (1) instruction and practice in proper self-performed tooth cleaning; special emphasis was directed towards interdental tooth cleaning; (2) dental prophylaxis including scaling and professional mechanical tooth cleaning (Axelsson & Lindhe 1978); (3) topical application of fluoride.

The members of the control group were recalled once a year and received traditional dental care; mainly directed towards the management of caries defects.

For details regarding the treatment provided for the test and control group panels, see Axelsson & Lindhe (1978, 1981).

Examinations regarding caries were performed once a year, but comprehensive re-examinations were carried out 3
years and 6 years after the baseline examination. For ethical reasons, the control group was discontinued after the 6-year examination. The members of the former control group were invited to take part in a preventive dental program administered by the Public Dental Health Service at Karlstad, Sweden.

The participants of the test group remained enrolled in the original preventive program. The content of this program remained basically unchanged during the subsequent 9 years. The interval between the prophylactic sessions, however, was varied between the subjects, depending on their individual need for preventive therapy. Thus, 65% of the subjects were recalled once a year, 30% twice a year, and 5% ("risk subjects"). Loss of more than 1 mm of attachment at more than 1 interproximal tooth surface during the preceding 6-year period and/or developed more than one caries lesion during the course of any of the 6 preceding 12-month periods) were recalled 3 to 6 times per year.

Results

3- and 6-year examinations

The results from the 3- and 6-year re-examinations have been reported previously (Axelsson & Lindhe, 1978, 1981). The overall data from the re-examinations revealed that, while the members of the test group had a low incidence of caries and improved periodontal conditions (Table 1), there was, during the 6 years in the control group, a mean increase of 12 to 15 decayed surfaces (2.3 D-s/year/subject) and an overall mean loss of periodontal attachment of 1.2 mm (0.2 mm/surface/year/subject).

15-year re-examination

Sample

317 (84%) of the 375 subjects who enrolled in the study in 1971–1972 remained in the preventive program and were available for the 15-year follow-up examination (Table 2). 4 subjects, 2 in age group 2, and 2 in age group 3, discontinued after 6 years because of lack of interest in further participation. The additional 54 subjects were lost for reasons unrelated to the study (10 subjects died; 1 in group 2, and 9 in group 3; 44 subjects moved from the city of Karlstad and were unable to return for preventive dental therapy).

Number of teeth and tooth loss

Fig. 1 presents the mean number of teeth (3rd molars excluded) that were present in the various age categories in 1972 (baseline) and 15 years later. There was an overall net loss of 0.2 teeth per subject in the 3 test groups. In the youngest age group, the number of teeth decreased from 26.9 to 26.8. The corresponding figures for the 2 older age categories were 25.5 to 25.3 and 19.3 to 18.8, respectively.

Out of 317 subjects who returned for the 15-year follow-up examination, 258 had lost no teeth during the observation period, while 51 subjects had lost 1 tooth, 5 subjects lost 2, 2 lost 3 and 1 subject lost 4 teeth. Loss of molars was more frequent than loss of premolars and incisors (Fig. 2). Thus, 34 individuals had lost 1 or more molars, while only 20 and 8 subjects were found to have lost 1 or more premolars and incisor teeth, respectively (Fig. 2).

The reason for tooth loss was monitored during the 15-year interval and the various causes are listed in Table 3. In all, 71 teeth were lost. The main reason (64%) for tooth loss was root fracture which occurred in 48 teeth which, at varying time intervals prior to the baseline examination in 1971–72, had been exposed to root canal therapy (and fitted with cast posts). 2 teeth were lost because of recurrent caries and 6 teeth were extracted because of marginal abscess development in initially furcation-involved molars.

Oral hygiene status

The % of tooth surfaces that harbored plaque in 1972 and 1987 is described in Fig. 3. At the baseline examination, about 60% of all tooth surfaces in the 3 groups were found to harbor plaque. As a rule, in all subjects, the buccal surfaces had the lowest and the approximal surfaces the highest plaque scores. The examination in 1987 revealed that the participating subjects had excellent
oral hygiene conditions. Thus, in all 3 age categories, the overall mean plaque scores were found to vary between 10 and 20%. The reduction of the plaque scores between the baseline and 15-year follow-up examination was similar in all 3 study groups and most pronounced at approximal tooth surfaces (Fig. 3).

Caries
The mean number of teeth (N-T) and decayed and filled teeth (DF-T) present per subject in the various age categories in 1972 and 1987 are presented in Fig. 4. The reduction of the number of DF-teeth corresponds in each age category to the number of teeth that were lost (Fig. 1). The incidence of caries, i.e., the frequency distribution of additional primary and secondary (recurrent) caries lesions (D-S) that occurred in the 317 subjects between 1972 and 1987 is described in Fig. 5. 165 subjects (> 50%) did not develop additional caries during the 15-year interval. 34 subjects acquired more than 2 new caries surfaces and only 2 subjects (0.6% of the sample) developed more than 10 caries lesions during the 15 years of monitoring. About 80% of the subjects in group 1, 55% in group 2 and 30% in group 3 had a caries incidence of zero during the 15-year interval. About 30% (groups 1 and 2) and 20% (group 3) of the subjects exhibited 2 or more caries surfaces between 1972 and 1987. The carious lesions that occurred during the 15-year interval were divided into primary and secondary (recurrent) carious surfaces (Fig. 6). In each age group, recurrent caries was more prevalent than primary caries. Thus, while the overall mean number of primary carious lesions varied between 0.1 and 0.3 per 15 years, the corresponding figures for recurrent caries were 0.7 and 0.9.

Gingivitis
At the baseline examination in 1972, about 20–25% of all gingival units were considered inflamed, i.e., bled on probing to the base of the pocket. In all 3 study groups, the interproximal units displayed a higher gingivitis score than buccal and lingual units. At the 15-year follow-up examination, only 2–3% of all gingival units showed sign of inflammation.

Probing pocket depth
The probing pocket depth data are reported in Fig. 7. The individual mean probing pocket depths calculated from measurements made in 1972 were found to be 2.0 mm (group 1), 2.1 mm (group 2) and 2.2 mm (group 3). The probing depths at buccal and lingual surfaces varied between 1.4 and 1.7 mm, while at the interproximal units, the corresponding figure was 2.7 mm. The examination in 1987 revealed that at this time interval, most periodontal pockets were shallow. Thus, at the 15-year follow-up examination, the mean probing depth at buccal and lingual surfaces was about 1 mm with a corresponding depth at interproximal surfaces of 2 mm.

Probing attachment level
Between 1972 and 1978, there was an overall gain of clinical attachment of 0.2 mm in the 317 subjects. This gain was further enhanced and amounted in 1987 to an overall improvement of the probable attachment level of 0.3 mm in relation to the values obtained from the 1972 examination.
toothing surfaces exhibited the largest number of sites that lost more than 1 mm of attachment (range 2.7–3.5% in the upper jaw dentition and 3.5–3.9% in the lower jaw). Between 0.7 and 1.4% interproximal surfaces suffered additional attachment loss, while 0.7 and 2.1% lingual units were identified as loser sites.

CPITN

Fig. 10 reports the findings from the baseline examination and the 15-year follow-up examination in terms of CPITN scores. In 1972, about 75% (groups 1 and 2) and 78% (group 3) of all gingival units required treatment (CPITN score > 0). 24% of all sites harbored calculus, 5% of sites had 4–5 mm deep periodontal pockets and about 1% of the sites received a CPITN score of 4, i.e., required not only scaling and root planing but possibly also surgical access therapy.

In 1987, the CPITN data disclosed that less than 2% of the tooth surfaces examined were in need of improved plaque measures and no surface required subgingival debridement or surgical therapy.

Discussion

The present clinical trial demonstrated that a preventive program which (i) stimulates the participants to improve their level of self-performed tooth cleaning, (ii) includes meticulous subgingival debridement (when required) and (iii) utilizes topical fluoride application through the daily use of fluoridated dentifrice, is an effective means against tooth loss, caries and periodontal disease.

In all respects, the findings from the 15-year follow-up examination confirmed the data obtained after 3 and 6 years of systematic preventive efforts (Axelsson & Lindhe 1978, 1981). The low incidence of caries and periodontal disease was maintained during the final 9 years of the trial, although the professional measures were repeated, in most subjects, only once a year. There are reasons to suggest, therefore, that the quality of the self-performed measures had a decisive influence on the decreased need for treatment. This observation is to some degree at variance with findings presented by Eneboth & Sundberg (1984). They were the principal investigators of a 5-year longitudinal field trial aimed at assessing the effect of in-
Fig. 7. Histogram illustrating the mean probing pocket depth data from the baseline and the 15-year follow-up examination. Data are reported for individual tooth surfaces as well as in terms of individual means (all).

Fig. 8. Bar chart illustrating the amount of gain of the probing attachment level that occurred between the baseline and the 15-year follow-up examination. Approximal tooth surfaces displayed most attachment gain, followed by lingual and buccal surfaces.

Improved levels of self-performed oral hygiene, combined with regularly repeated (once every 1–2 months) and professionally administered supragingival tooth cleaning, on caries and periodontal disease. According to the data reported, the preventive system utilized in the field study failed to retard development of caries and periodontal disease. It may be argued, therefore, that the annually repeated subgingival scaling that was performed at sites which bled on probing in the present study may have played an important role in the maintenance of long-term dental health.

The findings of the present long-term trial are, however, in agreement with data reported by Söderholm (1979) and Lindhe & Nyman (1984). Björn (1974) and Söderholm (1979) monitored the incidence of caries and periodontal disease during a 9-year period. They reported that traditional, symptomatic treatment failed to prevent progression of caries and periodontal disease. After the initial 9-year period, however, Söderholm (1979) initiated a preventive program including measures such as oral hygiene evaluation and instruction, scaling etc. The preventive measures were repeated once every 3 months during a 4-year period. A final examination disclosed that the dental care program utilized had markedly improved the dental health status of the participants.

Lindhe & Nyman (1984) reported on the treatment of patients with advanced periodontal disease and caries. Following active therapy which included oral hygiene instruction, scaling and root planing, periodontal surgery, and restorative measures, the patients were recalled for preventive measures during a subsequent 14-year period. Once every 3 to 6 months the participants were recalled for control of supra- and subgingival plaque, recurrence of bleeding pockets and caries lesions. Data obtained from the 14-year follow-up examination revealed that the maintenance program utilized in most subjects had entirely prevented recurrence of caries and periodontal disease. In a few subjects, however, despite the careful plaque control disease (caries as well as periodontal disease), recurrence was observed. Also among the participants in the present study, it was observed at the 15-year examination, that some subjects and surfaces displayed signs of caries and periodontal disease. It should be realized, therefore, that plaque control measures and topical fluoride application in a small number of especially disease-susceptible subjects may not be adequate to preclude caries and periodontal disease.

Acknowledgement

This study was supported by Praktiker-tjänst AB, Sweden.

Zusammenfassung

Über die Prävention von Karies und Parodontalerkrankungen. Ergebnisse einer 15 Jahre andauernden Langzeitstudie an Erwachsenen

Zur Bewertung der Wirkung eines Präventionsprogramms wurden 1971–72 insgesamt 375

Résumé
Prévention des caries et des parodontopathies. Résultats d'une étude longitudinale de 15 ans chez des adultes
En 1971–72, ein essai clinique destiné à mesurer l'effet sur l'incidence des caries et des parodontopathies d'un programme préventif, basé sur le contrôle de la plaque et l'application locale de fluorure, a été pratiqué chez 375 sujets adultes en tout. Après un examen initial, les sujets volontaires ont reçu un détartrage, un surfaçage radiculaire et le traitement classique des caries. Au cours des 6 années suivantes, ils ont été convoqués tous les 2–3 mois pour des soins préventifs. Après l'examen de rappel de 6 ans, l'intervalle entre les séances de prévention était augmenté: 95% des patients venaient seulement 1–2 fois par an pour les mesures préventives pendant les 9 années suivantes; un sous-groupe limité à environ 15 sujets, chez qui de nouvelles caries étaient produites ou chez qui une perturbation d'attaque ultérieure était apparue pendant les 6 ans de la période initiale, a été suivi 3–6 fois par an pendant les 9 années suivantes pour le contrôle de l'hygiène et pour le traitement préventif. Les examens renouvelés en 1987 ont mis en évidence que, chez les 317 sujets qui ont participé à l'étude pendant la totalité des 15 années, l'incidence de la carie était basse et il ne s'était pas produit de perte ultérieure du soutien de tissu parodontal. L'amélioration de l'hygiène bucco-dentaire personnelle, l'usage quotidien d'un dentifrice au fluorure et les séances régulièrement répétées de nettoyage professionnel préviendraient donc efficacement la récidive des maladies dentaires.

References
Axelsson, P. & Lindhe, J. (1978) Effect of...


Address:

Per Axelsson
Afd. för Tandhälsovård
Ångatan 47
652 30 Karlstad
Sweden