A Longitudinal Study of Combined Periodontal and Prosthetic Treatment of Patients With Advanced Periodontal Disease

by
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Clinical and laboratory research endeavors have revealed unanimously that most, if not all, forms of periodontal disease are plaque associated disorders. Consequently, treatment of gingivitis and periodontitis must always involve debridement, elimination of deepened periodontal pockets and other retention factors for plaque and the institution of a careful plaque control program including regularly repeated oral prophylaxis and tooth cleaning instruction. Studies by Lövdal et al.,1 Suomi et al.,2 Ramfjord et al.,3,4 Lindhe and Nyman,5 Rosling et al.,6 Axelsson and Lindhe7 have documented that such treatment will eliminate clinical signs of gingivitis and prevent further deterioration of the supporting tissues.

Frequently in cases of advanced periodontitis, the destruction of the attachment apparatus has reached a level which calls for extraction of several teeth. This implies that towards the end of the initial treatment phase5 of such patients only a few teeth may remain, teeth which in addition to having reduced periodontal tissue support often also exhibit pronounced hypermobility or even signs of progressive, i.e. gradually increasing, mobility. In such cases there is an obvious need for splinting and additional prosthetic treatment,6 even if prevalent concepts prescribe that in this particular situation prosthetic treatment including fixed bridgework is hazardous.9-11 It has been demonstrated,12,13 however, that teeth with severely reduced periodontal support and with progressive mobility can serve as reliable abutment teeth for extensive fixed splints/bridges provided periodontal health has been established and can be maintained in the remaining dentition, and provided the bridgework is designed as to preclude undue stress concentrations in the supporting apparatus.

The present investigation describes the result of treatment of a group of patients who initially suffered from advanced periodontitis, in many instances complicated by tooth hypermobility in several sections of the dentition. Following treatment, which in several cases involved multiple extractions and splinting combined with prosthetic rehabilitation, all patients were enrolled in a carefully designed plaque control program. The study also reports on the frequency of failures of the combined periodontal and prosthetic treatment.

Materials and Methods

The material consisted of 299 individuals (aged 23–72 years, mean age 48.7 years) who during the period 1969 to 1973 were referred to the Department of Periodontology, University of Gothenburg, for periodontal treatment. The limiting criterion for acceptance of patients for this study was that their dentition had lost 50% or more of the periodontal tissue support. In addition, they should be (i) willing to accept periodontal treatment including tooth extractions, periodontal surgery and, if indicated, prosthetic treatment, (ii) capable of maintaining optimal plaque control and, (iii) willing to appear for regular appointments for additional maintenance care.

In some patients, a well-functioning dentition could be established without prosthetic treatment (Group I). The periodontal status of these patients 5 years after treatment as well as a detailed description of the various therapeutic procedures utilized have been presented earlier.13 Forty-eight of these patients (22 males and 26 females), namely those who still 8 years following initial treatment participated in the controlled oral hygiene program and appeared at the 8-year follow-up reexamination constituted the “non-bridge treatment group” (Group I) described in the present paper.

The remaining 251 patients described here displayed at the initial examination a similar degree of periodontal disease as the patients of Group I but, in addition, the breakdown of the periodontal tissues around certain teeth had reached a level where tooth extractions and subsequent prosthetic replacement were required. Out of these 251 individuals, every fifth (in consecutive order according to date of commencement of treatment), i.e. in all 50 patients, were selected to form the “bridge-treatment group” (Group II). In these 50 patients, 74 fixed bridges were placed. According to the design of the bridgework “the bridge treatment group” was divided into three subgroups:

Group IIa: 21 bridges of cross-arch extension with abutment teeth present at the distal termination of the bridges. In this bridgework, the number of pontics between two neighboring abutments ranged from one to eight.

Group IIb: 39 bridges of cross-arch extension with distal cantilever segments in one or both sides of the jaw. In this bridgework, the mean number of free-end pontics per cantilever segment was 2.3 (range 1–7).

Group IIc: 14 bridges of unilateral extension.

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The patients of Group II have been followed for 5 to 8 years (mean 6.2 years).

The outline of treatment of periodontitis in the patients of the “bridge treatment group” was identical to that described for the patients of Group I.

Following the active phase of treatment (initial treatment), all patients of Group I as well as of Group II were placed in a maintenance care program including recall appointments every 3 to 6 months. At these periodic recalls, each patient was scaled and also was given careful professional tooth cleaning\(^{14}\) and oral hygiene instruction.

Immediately after completion of the initial treatment and then once a year, all patients were reexamined regarding:

1. Oral hygiene status (Plaque Index\(^ {15}\)).
2. Gingival condition (Gingival Index).\(^ {16}\)
3. Pocket depth (measured with a calibrated periodontal probe to the nearest one millimeter).
4. Attachment level (from well-defined landmarks on the tooth surfaces.\(^ {2,3,17}\) The assessments were made to the nearest one millimeter. Assessments regarding oral hygiene, gingivitis, pocket depths and attachment levels (1, 2, 3 and 4) were made by the same dentist and included all parts of the dentition and all four surfaces (mesial, distal, buccal, lingual) around each tooth. The individual mean values were calculated.
5. Alveolar bone height (Bone Score\(^ {18}\)).

The bone level at the mesial and distal surface of each tooth was measured in radiographs obtained according to a method described by Eggen.\(^ {19}\) Individual mean Bone Scores were calculated. The radiographic readings were made by two dentists.

In addition, information was collected regarding technical failures which were detected in the bridgework\(^*\) during the maintenance period. An analysis was carried out to assess the frequency of and reasons for failures in all 251 patients who received prosthetic treatment during the period 1969 to 1973. In all, 332 fixed bridges had been placed, and the various bridgework had the following general design:

- 139 bridges of cross-arch extension with abutment teeth present at the distal termination of the bridges. In this bridgework, the number of pontic units between two neighboring abutments ranged from 1 to 8.
- 159 bridges of cross-arch extension with distal cantilever segments in one or both sides of the jaw. In this bridgework, the mean number of free-end pontics per cantilever segment was 2.2 (range 1–7).
- 34 bridges of unilateral extension.

### Statistical Analysis

Analysis of variance was used for testing differences in the various groups with respect to alterations of Plaque- and Gingival Index scores, pocket depth, attachment level and alveolar bone height.

### Results

#### Oral Hygiene and Gingival Condition

The individual mean PII scores (Table 1) for the abutment teeth assessed immediately after the initial treatment in the three “bridge treatment groups” were 0.32 (Group IIa), 0.39 (Group IIb) and 0.42 (Group IIc). The corresponding value in the “non-bridge treatment group” (Group I) was 0.40. The results from the final examination (5–8 years in the “bridge treatment groups” and 8 years in the “non-bridge treatment group”) revealed that the patients had maintained low PII scores.

The GI scores (Table 1) which at the termination of the initial treatment phase varied in the different groups between 0.30 and 0.42, showed during the maintenance period consistently low values with only insignificant variations from the initial mean scores. The GI scores calculated from measurements made at the final examination in the four groups of patients varied between 0.28 and 0.35.

#### Pocket Depth and Attachment Level

The mean pocket depths for all tooth units at the end of the initial treatment phase were in Group I 2.1 mm and in Group IIa 2.3 mm, Group IIb 2.1 mm, Group IIc 2.3 mm (Table 2). In none of the treatment groups did these values vary in a significant way during the course of the study. The mean pocket depths calculated for the 4 different groups at the final examination were 2.4 mm, 2.4 mm, 2.3 mm and 2.3 mm respectively.

The attachment level measurements (Table 2) revealed that no additional loss of clinical attachment occurred during the 5 to 8 years of observation around the teeth which remained following the initial treatment.

#### Alveolar Bone Height

The results of the measurements of the interproximal alveolar bone height are presented in Tables 3 to 6. Table 3 shows that the bone level was maintained unchanged in all four groups over the entire observation period. A further analysis revealed that the bone height was main-

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* The periodontal and prosthetic treatment described in the present study has been carried out by staff members and graduate students of the Department of Periodontology, University of Gothenburg.
tained equally well around vital and nonvital, root-filled teeth (Table 4) as around one-rooted (hemisected), and multirooted molar abutments (Table 5). The assessments furthermore disclosed that the bone height remained unchanged around all terminal abutment teeth which were adjoined with distal cantilever pontics irrespective of the length of the cantilever segment (Table 6).

### Technical Failures

The analysis of the total material (332 bridges in 251 patients) regarding frequency of and reasons for technical failures which were encountered in the various bridgework after placement, gave the following result:

1. **Loss of retention** of retainer crowns from abutment teeth (11 bridges, 3.3%). This failure occurred in six bridges of cross-arch extension with distal abutment teeth present, and in five bridges of cross-arch extension with distal cantilever segments.

2. **Fracture of bridgework** (seven bridges, 2.1%). Such fractures were noted in one bridge of unilateral extension, in three bridges of cross-arch extension with distal abutment teeth, and in three bridges of cross-arch extension involving cantilever segments.

### Table 2. Pocket Depth and Alterations in Attachment Level Assessed Immediately After the End of the Active Treatment Phase ($\bar{X}_1$) and at the Final Examination ($\bar{X}_2$)

<table>
<thead>
<tr>
<th>Pocket depth (mm)</th>
<th>Alterations in attachment level (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{X}_1$</td>
<td>$\bar{X}_2$</td>
</tr>
<tr>
<td>Group I</td>
<td>2.1</td>
</tr>
<tr>
<td>Group IIa</td>
<td>2.3</td>
</tr>
<tr>
<td>Group IIb</td>
<td>2.1</td>
</tr>
<tr>
<td>Group IIc</td>
<td>2.3</td>
</tr>
</tbody>
</table>

### Table 3. Bone Height Measurements

$\bar{X}_1$ = Individual mean (patient) Bone Score ± standard deviation assessed from radiographs obtained immediately after the end of the active treatment phase. $\bar{X}_2$ = Bone Score assessed from radiographs obtained at the final examination. It should be observed that for the patients in Group I the $\bar{X}_2$ values always represent data collected at the 8-year follow-up examination. For Group IIa, IIb and IIc, the $\bar{X}_2$ values represent data from reexaminations made between 5 and 8 years after the end of active treatment. NS = nonsignificant. SE = standard error.

<table>
<thead>
<tr>
<th>$\bar{X}_1$</th>
<th>SD</th>
<th>$\bar{X}_2$</th>
<th>SD</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>6.41</td>
<td>0.65</td>
<td>6.37</td>
<td>0.61</td>
</tr>
<tr>
<td>Group IIa</td>
<td>5.98</td>
<td>0.64</td>
<td>5.83</td>
<td>0.71</td>
</tr>
<tr>
<td>Group IIb</td>
<td>5.66</td>
<td>0.77</td>
<td>5.68</td>
<td>0.71</td>
</tr>
<tr>
<td>Group IIc</td>
<td>5.34</td>
<td>0.61</td>
<td>5.26</td>
<td>0.58</td>
</tr>
</tbody>
</table>

### Table 4. Bone Height Measurements of Nonvital, Endodontically Treated and Vital Abutment Teeth*

<table>
<thead>
<tr>
<th>Abutment teeth</th>
<th>N</th>
<th>$\bar{X}_1$ ± SD</th>
<th>$\bar{X}_2$ ± SD</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endodontically treated</td>
<td>47</td>
<td>5.57</td>
<td>0.68</td>
<td>5.54</td>
</tr>
<tr>
<td>Vital</td>
<td>52</td>
<td>5.70</td>
<td>0.74</td>
<td>5.72</td>
</tr>
</tbody>
</table>

* Only those patients have been included in whom both types of teeth were utilized as abutments.

### Table 5. Bone Height Measurements of Hemisected and Nonhemisected Molar Abutment Teeth*

<table>
<thead>
<tr>
<th>Molar abutment teeth</th>
<th>$\bar{X}_1$ ± SD</th>
<th>$\bar{X}_2$ ± SD</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemisected</td>
<td>6.15</td>
<td>0.85</td>
<td>6.18</td>
</tr>
<tr>
<td>Nonhemisected</td>
<td>5.64</td>
<td>0.57</td>
<td>5.61</td>
</tr>
</tbody>
</table>

* Only those patients have been included in whom both types of teeth were utilized as abutments.

### Table 6. Bone Height Measurements (Group IIb) Around the Terminal Abutment Tooth Adjoined With Free-end Pontics

<table>
<thead>
<tr>
<th>No of free-end pontics</th>
<th>N</th>
<th>$\bar{X}_1$ ± SD</th>
<th>$\bar{X}_2$ ± SD</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>5.94</td>
<td>0.84</td>
<td>5.97</td>
</tr>
<tr>
<td>2</td>
<td>18</td>
<td>5.37</td>
<td>0.89</td>
<td>5.45</td>
</tr>
<tr>
<td>3 or more</td>
<td>10</td>
<td>5.24</td>
<td>0.71</td>
<td>5.24</td>
</tr>
</tbody>
</table>

### Discussion

The present investigation showed that it is possible to prevent recurrence of gingivitis of clinical importance and to terminate progression of periodontal tissue breakdown in patients who, following proper periodontal treatment, were enrolled in a well controlled oral hygiene program. The treatment procedures which in the present trial resulted in healing of the periodontal tissues, included the removal of the soft and hard bacterial deposits and the elimination of retention factors for plaque including ill-fitting restorations and deepened periodontal pockets. The periodontal conditions of the patients of Group I 5 years after initial treatment have been described previously. In the paper referred to, it was concluded: "It is possible by a detailed plaque control program not only temporarily to cure the disease, but also to prevent further progression of periodontal breakdown, even in patients with severely reduced periodontal support." In the present study, the same patients were reexamed 8 years after initial treatment. The final reexamination revealed that still after 8 years of careful maintenance care, they displayed an unaltered attach-
ment level and an unaltered height of alveolar bone. These findings, which are consistent with observations reported by Lövdahl et al., Suomi et al., Ramfjord et al., Axelsson and Lindhe show that periodontal health can be maintained in patients for whom, following initial treatment, the recurrence of plaque infection is prevented.

The present findings furthermore revealed that debridement, elimination of deepened pockets and the establishment of a carefully designed maintenance program is effective also in patients for whom splints or bridge restorations were part of the initial treatment. This simply means that the periodontal tissues around teeth which are serving as abutments for fixed bridgework do not react to treatment in a different way than the supporting tissues around "non-abutment" teeth. The observations made here also disclosed that differences in the design of the bridgework (i.e. unilateral or cross-arch design, length of pontic- or cantilever segments, the utilization of hemisected- or nonhemisected molars as abutment teeth etc.) will not jeopardize the treatment which in all patients was aimed at eliminating the plaque infection and the retention factors for plaque.

In the present study, the initial treatment of periodontal disease around abutment teeth and "non-abutment" teeth was similar. In all bridgework made, the marginal fit of the retainer crowns of the abutment teeth were placed in a supragingival position. This means that the design of the maintenance care program for abutment- and "non-abutment" teeth was similar. The supragingival location of the crown margins facilitates the inspection of the marginal fit of the retainers and the early discovery of incipient caries lesions. Furthermore, studies by Waerhaug, Karlsen, Silness, Valderhaug and Birkeland have shown that a subgingival location of the crown margins favors plaque accumulation, thereby enhancing the risk of recurrence of periodontal disease. In addition, Valderhaug and Heloe in a 5-year longitudinal study reported that the incidence of caries could be kept as low around crown margins in supragingival position as around those located below the gingiva in patients who participated in a regularly repeated oral hygiene program.

Even if the establishment and maintenance of periodontal health around the abutment teeth are prerequisites for a proper prognosis of a fixed bridge, certain elementary principles regarding the design of the artificial constructions cannot be neglected. The most important factor in our view is that a status quo of bridge stability can be obtained. This means that increasing (progressive) mobility or drifting of the bridgework with time has to be avoided. The problems involved in obtaining stability of fixed bridgework in patients with severely reduced periodontal support, however, will not be further discussed in this paper, since this aspect of the treatment has been extensively analyzed in previous publications.

Although in the present trial exceptional efforts were made to prevent the occurrence of technical failures in the bridgework, during the observation period around 8% (26 bridgework) of the fixed restorations had to be replaced due to (1) loss of retention, (2) fracture of the bridgework, (3) fracture of abutment teeth. A further analysis revealed that in all cases of failure in the prosthetic treatment, certain fundamental principles regarding the design and construction of the bridgework had been overlooked. A few examples will illustrate some of the frequent reasons for failures.

In the present material, loss of retention occurred in abutment teeth fitted with partial crowns. It is well known that the rigidity of an intact tube, such as a full crown, is much higher than that of a tube which has been cut open. This means that a partial crown in comparison to a full crown has a reduced resistance to deformation. The ultimate consequence of plastic deformation of a crown in a bridgework is fracture of the luting cement and subsequent loss of retention. Loss of retention also was noted in some patients whose bridgework included long pontic spans and long free-end segments. In order to secure proper retention for bridgework of this kind it is necessary to give the prepared portion of an abutment tooth maximum length and minimal taper, i.e. the length of the diagonals of the prepared portion of the abutment tooth must exceed the diameter of its base (For discussion see Hegdahl and Silness).

Figure 1 illustrates a maxilla in which bridgework of cross-arch extension is to be inserted. If we assume that a "normal" intermaxillary relationship (normal overbite and overjet) is prevailing, protrusive movements of the mandible will produce a force in occluso-frontal direction (arrow, Fig. 1) operating on the distal abutment crown. A dislodging effect of such a force can be prevented provided the distal aspect of the molar is made parallel to the mesial (and distal) surface of the canine and the buccal (and lingual) surface of the incisor. In two of the bridgework (Group IIA) described in this paper, the distal surfaces of the molars were prepared with a large convergence angle in relation to the canines.

Figure 1. The distal surface of the molar is prepared parallel to the mesial surface of the canine and the buccal surface of the incisor in order to counteract the occluso-frontally directed dislodging force (arrow) acting on the molar abutment tooth on protrusive mandibular glide. The retentive capacity is further increased by box preparation on the buccal surface of the molar.
As a consequence, the bridgework had no “self-retention” in the molar area, the cement film became the sole retention factor, and after a few months the restorations lost the retention of the distal abutment tooth. In the bridgework discussed, retention was improved following placement of new restorations by utilizing box preparations in the molar abutments. Thus, in order to avoid loss of retention of bridgework with long pontic spans, it is imperative to obtain parallelism between the prepared surfaces of the various abutment teeth.

Fracture of the bridgework occurred in the present material in seven bridges. An analysis of the reason for this type of failure disclosed that the metal constructions of these bridges were under-dimensioned. In cases in which long pontic spans or cantilever segments are used, the stress-increasing effect produced by the pontic segment elongation must be compensated for by increasing the height of the various components of the bridge (i.e. crowns, pontics, solder joints, etc.) in the loading directions.29

Fracture of abutment teeth in the present material was found to occur more frequently in root-filled than in vital teeth and appeared primarily in root-filled teeth fitted with posts and serving as terminal abutments for free-end segments (Fig. 2). In order to minimize the risk for such root fractures (1) the root canal should not be prepared too wide, (2) a gold collar should circumscribe the neck of the tooth. Using standard models, Sass et al.31 showed that the strength of a rootfilled tooth with metal post and a gold collar is more than 10 times that of a corresponding tooth without collar. It should also be understood that the wider the gold collar is, the higher becomes its retentive capacity.

**Summary**

The purpose of the present investigation was to present the results of periodontal and prosthetic treatment of patients with advanced breakdown of the periodontal tissues. The material consisted of 299 individuals. In 48 of the patients (Group I), a well-functioning dentition could be established with periodontal treatment only, whereas in the remaining 251 patients prosthetic therapy was required subsequent to the treatment of the periodontal tissues. Out of these 251 individuals, every fifth patient (50 patients in all) was selected to form Group II in the present study. Following the active phase of treatment, all patients were placed in a maintenance care program which included recall appointments every 3 to 6 months. At these periodic recalls, scaling, professional tooth cleaning and repeated oral hygiene instructions were given to each individual. The patients of Group I have been followed up for 8 years and those of Group II for 5 to 8 years (mean 6.2 years).

Following the termination of the initial treatment and then once a year, the following parameters were assessed: Plaque Index, Gingival Index, pocket depth, attachment level and marginal alveolar bone height. In addition, an analysis was carried out to assess the frequency of and

**Figure 2a.** Radiographic presentation of a patient of Group IIb before treatment. The upper right first and second premolars and the upper left second incisor and first premolar were extracted. The remaining maxillary teeth were periodontally treated and the patient restored with a new maxillary fixed bridge with three cantilever units on the left side. The original mandibular bridge was preserved after extraction of the two left molars and periodontal treatment of the remaining abutment teeth. b. Radiographs obtained at the 5-year control of the patient seen in Figure 2a. Two weeks after this follow-up appointment, the patient reappeared with the upper left canine fractured. The root of the tooth was extracted. c. Control radiographs of the patient presented in Figures 2a and b 8 years after treatment, i.e. 3 years after the extraction of the root of the maxillary left canine. Note that no further loss of alveolar bone has occurred around any of the maintained abutment teeth following the initial treatment (compare with Figure 2a).
the reasons for technical failures which were detected in bridgework during the maintenance period. This analysis comprised the total patient material (251 individuals) given the combined periodontal and prosthetic treatment. In all, 332 fixed bridges of various extension were analyzed.

The results showed that following periodontal treatment, periodontal health can be maintained in patients enrolled in a controlled oral hygiene program. The type of maintenance care exercised in the present study was equally effective in patients for whom fixed bridgework was part of the initial treatment. Severe reduction of periodontal support around the abutment teeth and differences in design of the bridgework did not influence the periodontal status during the observation period. However, failures of technical nature occurred in 26 out of the 332 bridges. These failures appeared as (1) loss of retention of retainer crowns from abutment teeth in 11 bridges, (2) fracture of bridgework in seven bridges, and (3) fracture of abutment teeth in 8 bridges. The reasons for these failures are discussed.

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REFERENCES


