Results of Periodontal Treatment Related to Pocket Depth and Attachment Level. Eight Years.*

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IN PREVIOUS PAPERS we have reported longitudinal results of periodontal treatment based on mean values for all treated teeth,[1,2] and analysis based on mean values from the half mouths of patients.[3] These methods of analysis, however, did not reveal specifically what happened over time to pockets of various depth and attachment levels.

Prognosis is a very elusive, but fundamentally important consideration in treatment planning, and since pocket depth and loss of attachment traditionally are basic elements in assessment of periodontal prognosis, it was decided to analyze our longitudinal treatment results with the initial pocket depth and attachment level serving as reference.

The first part of the analysis is a general appraisal of the longitudinal value of periodontal therapy related to variations in initial pocket depth, and the second part attempts to determine if treatment modality will influence the maintenance of periodontal attachment dependent on variations in initial severity of the disease.

MATERIAL AND METHODS

Almost all of the patients in the present study were included in a 5 year follow-up report[3] in 1975. The basic considerations in selection of patients and experimental design are explained in that paper.[3]

In the present report are included results from 78 patients who had completed at least the first 1 year recall and scoring. They had a total of 1974 teeth (an average of approximately 25 teeth). At the 5 year postoperative recall there were 72 patients, and at 6 years, 64. However, this number fell off to 43 patients with 1038 teeth after 8 years, indicating that it becomes difficult to extend a longitudinal study with regimented recall beyond 5 years of follow-up, although some of these patients have not completed 8 years and are not necessarily lost to the study.

Following initial scoring, scaling, root planing, instruction in oral hygiene, and occlusal adjustment, all of the patients on a randomized basis had each half of their mouths treated with one of the following surgical procedures: (1) subgingival curettage, (2) modified Widman flap surgery,[4] or (3) pocket elimination surgery.[5] The patients were recalled for prophylaxis by a dental hygienist every 3 months, and scored by a periodontist annually.

STATISTICAL ANALYSIS

Analyses were performed utilizing statistical programs of the Michigan Interactive Data Analysis System (MIDAS). Frequency distributions were obtained of the initial number of buccal, lingual, mesial and distal pockets which occurred in three categories of severity—Class I, no pathological pocket depths, Class II, pockets 4 to 6 mm., and Class III, pockets 7 to 12 mm.

For descriptive purposes tooth means were obtained for the change in depth of pocket and attachment level at yearly intervals following treatment, and the 95% confidence intervals about these means were computed. Means of the differences between measurements were derived for buccal, lingual, mesial, and distal surfaces of pockets 1 to 8 mm initially. Descriptive statistics were also obtained for changes in depth of pocket and level of attachment when all surfaces were collapsed in a specific level of pocket depth (1–8 mm) before treatment.

Patient means were then generated using teeth in the same severity category from each patient. This satisfies the assumption of independence of the experimental unit thus allowing statistical testing of differences.

The Student's *t* test was performed to test the hypothesis that the patient mean in each severity category was zero. The null hypothesis was rejected at the 0.05 level of significance.

A one-way analysis of variance was used to test the hypothesis of equal surgical treatment effects in the three levels of severity at each of the eight yearly intervals following treatment. The test was performed on patient means of change of pocket depth and change of attachment level. If the hypothesis of equal treatment effects was rejected at the 0.05 level of significance using ANOVA, Scheffe's method for multiple comparisons was used to determine which of the pairs of treatments differed.

RESULTS

Although all of the patients initially had at least one periodontal pocket extending 4 mm or more apically to the cementoenamel junction, most of their gingival crevices were shallow, especially on the buccal (85%) and

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lingual surfaces (65%) of the teeth (Figs. 1 and 2). Approximately one half of the interproximal crevices were 4 mm or deeper when measured at the mesio- and distobuccal surfaces close to the contacts and without tilting the probe (Fig. 3). This means that what happens to the shallow crevices will be weighted heavily when computing patient means for change in pocket depth and attachment level, and will mask what happens to the deep pockets which are of greatest concern to the therapist.

Combined Response to all Three Tested Modalities of Treatment

Although the frequency and depth of the periodontal pockets were greater for the interproximal than for the buccal and lingual surfaces of the teeth, the changes in pocket depth and attachment level following treatment did not vary significantly when pockets of the same initial depth from all surfaces were compared (Figs. 4 and 5). This similarity among all surfaces in response to treatment was tested and confirmed for each of the 8 years of follow-up. The fact that pockets and attachment levels on the four tooth surfaces behaved similarly when the initial severity was constant, made it possible to collapse the data from the four surfaces and report the means (Figs. 6 and 7).

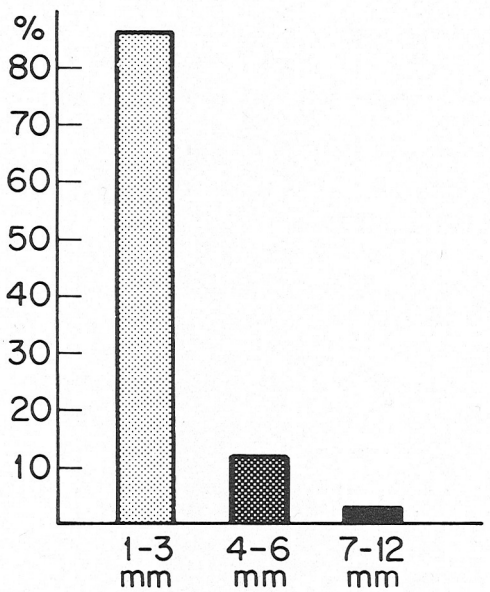

FIGURE 1. *Frequency distribution of buccal pockets by initial severity.*

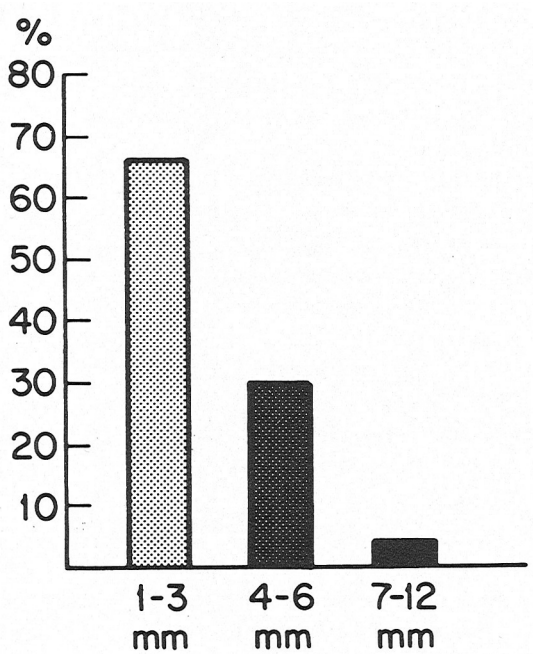

FIGURE 2. *Frequency distribution of lingual pockets by initial severity.*

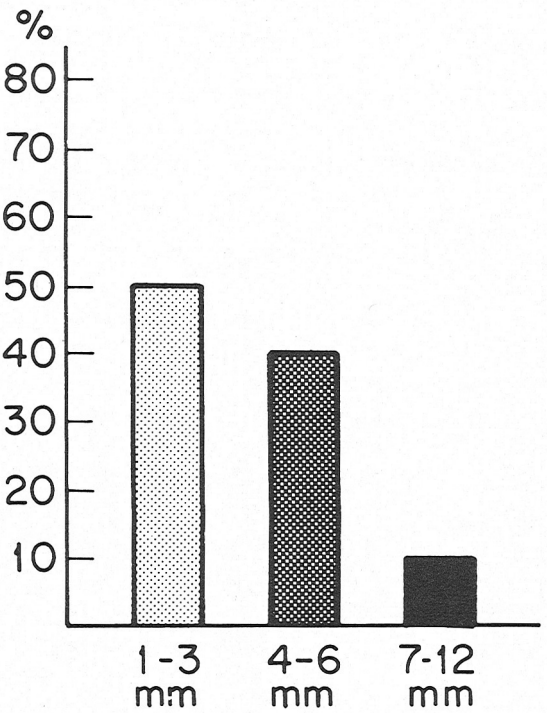

FIGURE 3. *Frequency distribution of mesial and distal pockets by initial severity.*

A very important consideration in periodontics is what happens to pocket depth after treatment. Are deep pockets more likely to return to pretreatment levels than shallower pockets?

As indicated in Figure 8, the amount of pocket reduction after treatment is related directly to the initial pocket depth with the greatest reduction for the deepest pockets. The initial reduction in pocket depth and the increase in crevice depth for 1 to 2 mm crevices are essentially unchanged from year 1 to year 8, although there is a slight return of depth of 0.5 mm of the treated pockets from year 1 to year 4; with no changes from year 4 to year 8. The deepening of the shallow gingival crevices from 1 mm initially to 2 mm after 8 years (a deepening of 1 mm) may be explained both on the basis of inclusion of such areas in surgical procedures to gain access to adjacent pockets, and statistically by "regression toward the mean". Adding to the "regression towards the mean" phenomenon is that a pocket depth of zero is practically never found by our scoring system, so crevices of 1 mm depth cannot be reduced by error in scoring or otherwise. This bias precludes reduction in 1 mm depth while

increase in depth may be recorded. Similarly, pockets of 1 to 2 mm often have no loss of attachment, so no gain of attachment can occur by our scoring.

The bar graph in Figure 9 compares the initial pocket depth with the depth of the same pockets after 8 years. Again, it is apparent that periodontal pockets 4 mm or deeper stay significantly reduced over 8 years after periodontal therapy, and generally tend to stay within the range of 3 to 4 mm.

When changes in attachment levels are related to the initial pocket depth (Fig. 10), a consistent relationship is apparent between attachment changes and initial pocket depth. There is an initial and sustained gain of attachment in pockets 5 mm and deeper, and some loss in the shallow crevices 1 to 3 mm deep.

The explanation for the loss in the shallow crevices is the same as for the increased crevicular depth, inclusion in surgical treatment with unavoidable loss, and regression toward the mean statistically. These phenomena are most noticeable for the crevices of only 1 mm initial depth which often have no initial attachment loss.

In order to illustrate the results in a way most relevant to dental practice, and since the pockets and attachment levels from 1 year after treatment behaved essentially in

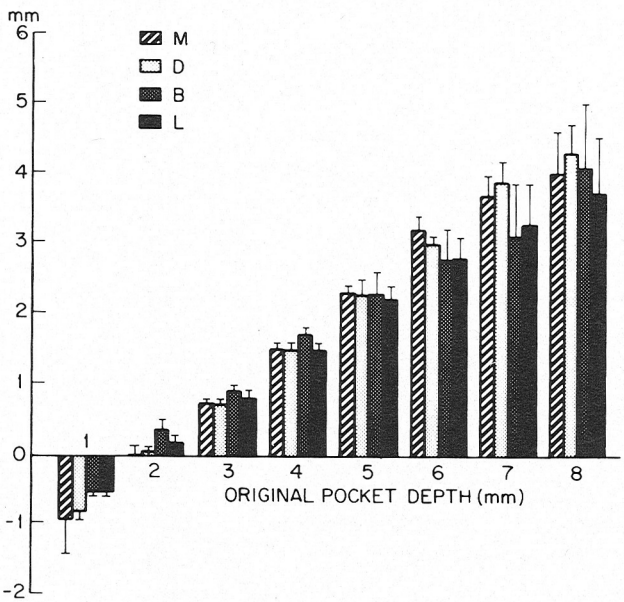

FIGURE 4. *Mean change in depth of pocket by tooth surface (1 year, 95% C.I.).*

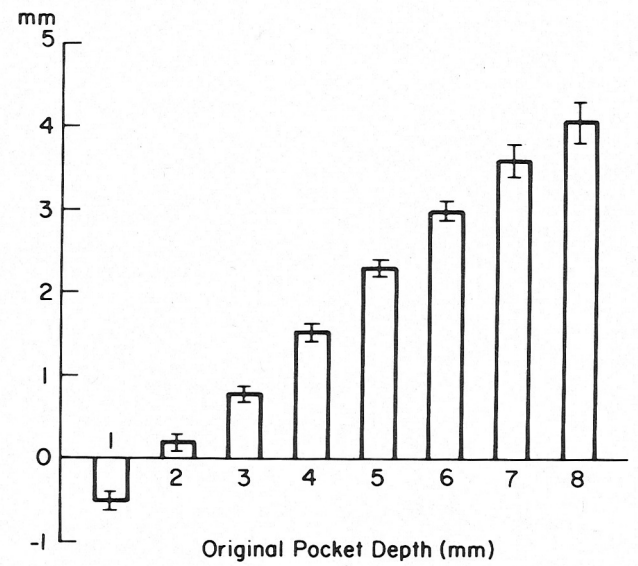

FIGURE 6. *Mean change in depth of pocket for all tooth surfaces (1 year, 95% C.I.).*

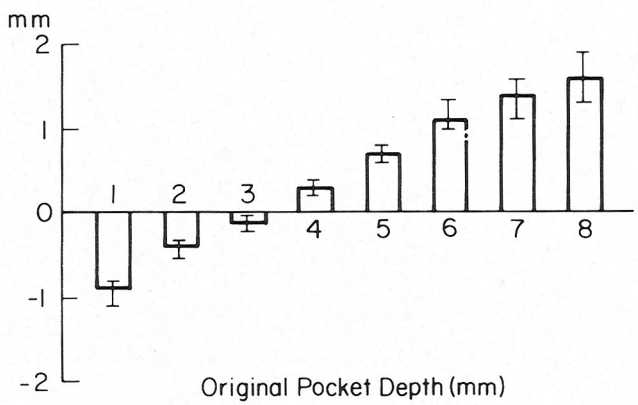

FIGURE 7. *Mean attachment change for all tooth surfaces (1 year, 95% C.I.).*

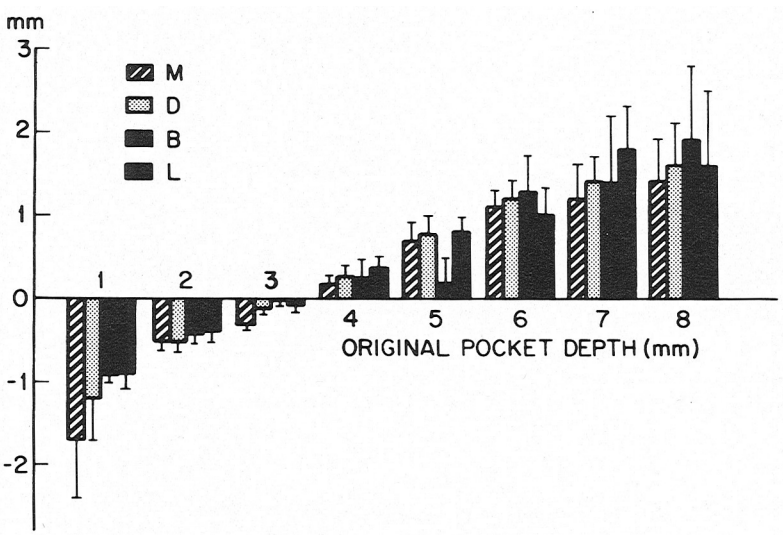

FIGURE 5. *Mean attachment change by tooth surface (1 year, 95% C.I.).*

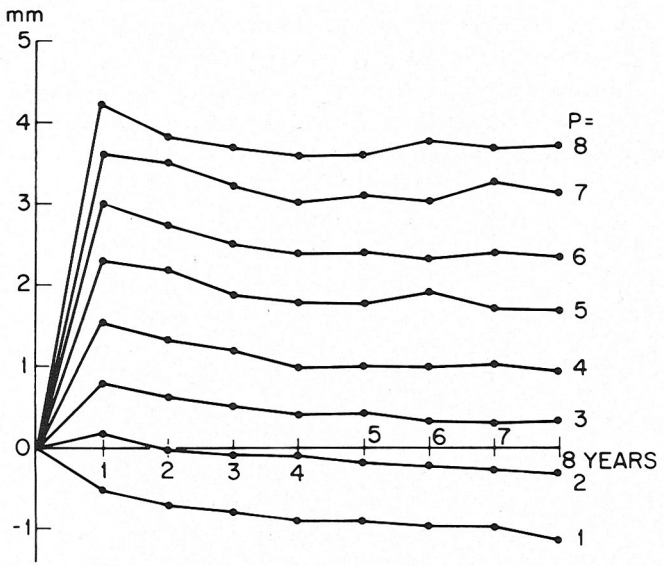

FIGURE 8. *Pocket reduction by initial pocket depth (P) for all surfaces.*

a linear fashion, a grouping according to severity was adopted. The 1 to 3 mm crevices represent Class I with no pathological pocket depth. Class II with 4 to 6 mm pockets signifies moderately advanced periodontitis, and Class III with 7 to 12 mm pockets indicates advanced periodontitis.

A line graph of pocket reduction based on this classification (Fig. 11) indicates a well sustained significant reduction of 4 mm for the deep pockets (7–12 mm), and a lesser, but well sustained significant reduction of the moderately deep pockets (4–6 mm). The areas of no pockets (1–3 mm) show no significant change over eight years.

A line graph of attachment changes over 8 years arranged in a similar manner (Fig. 12) depicts a sustained significant gain of attachment both in the deep and moderately deep pockets, while in the areas of no initial pockets (1–3 mm) there was an initial and sustained significant loss of attachment, although less than 1 mm over 8 years. Real and artifactual reasons for this loss already have been suggested.

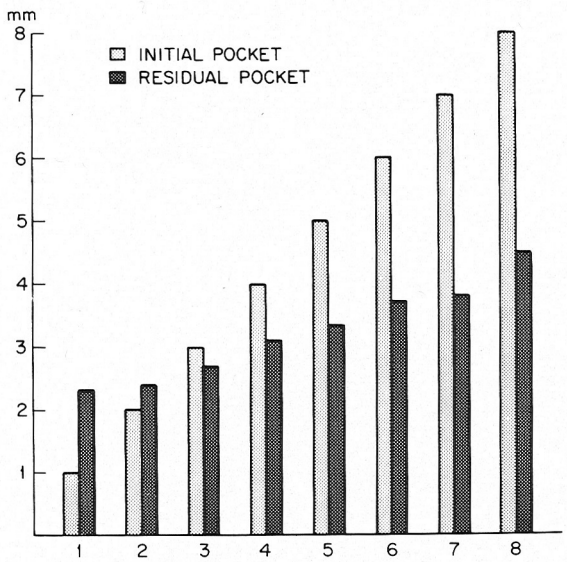

FIGURE 9. *Initial pocket depth compared to pocket depth after 8 years.*

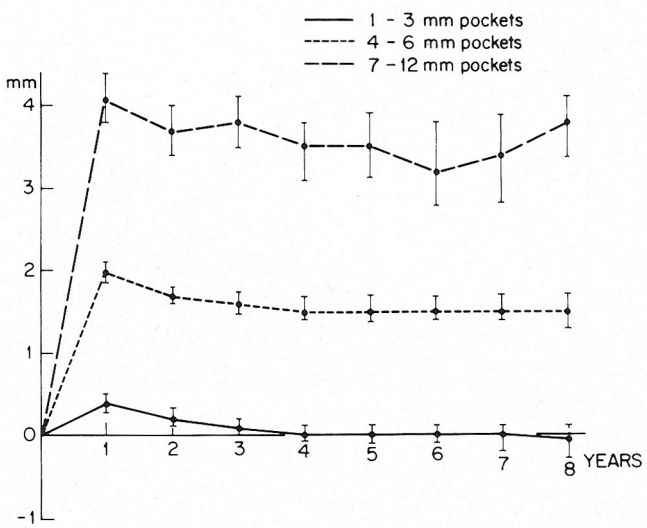

FIGURE 11. *Pocket reduction (patient means) for all surfaces by initial severity (95% C.I.).*

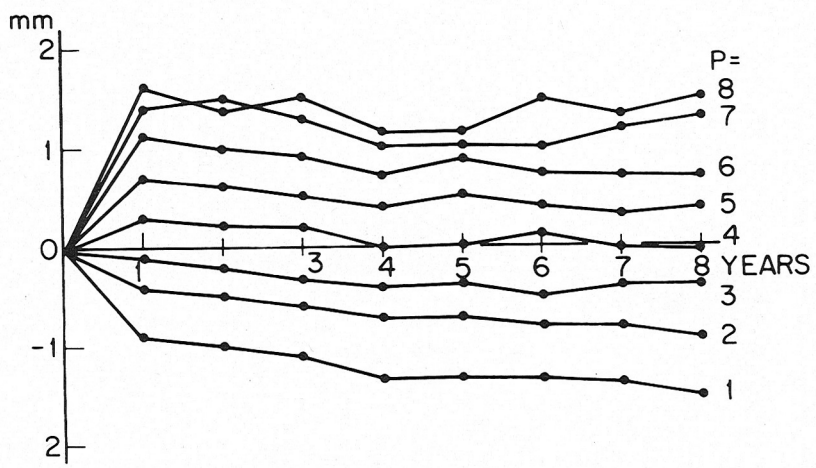

FIGURE 10. *Attachment change by initial pocket depth (P) for all surfaces.*

The Effect of Modality of Treatment on the Results

When pocket reduction following treatment is related to the method of surgical treatment for areas of no pockets Class I (1–3 mm crevices), the results are very similar for the three modalities (Fig. 13). Although pocket elimination surgery and modified Widman flaps reduced and prevented return of crevice depth slightly but consistently better than curettage (Fig. 13), the differences are statistically significant only for a few of the intervals and there does not appear to be a consistent magnitude or trend of obvious clinical significance.

There was a significantly greater loss of attachment in the shallow crevices following surgical pocket elimination than following curettage (Fig. 14). Although this difference is significant only for the first 4 years after the initial surgery, there is a consistent separation between the results following these two methods during the entire period of observation, with the results from the modified

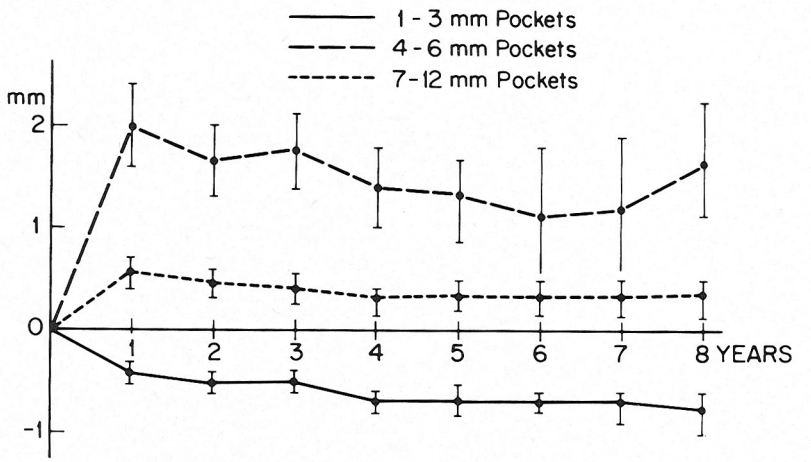

FIGURE 12. *Attachment change (patient means) for all surfaces by initial severity (95% C.I.).*

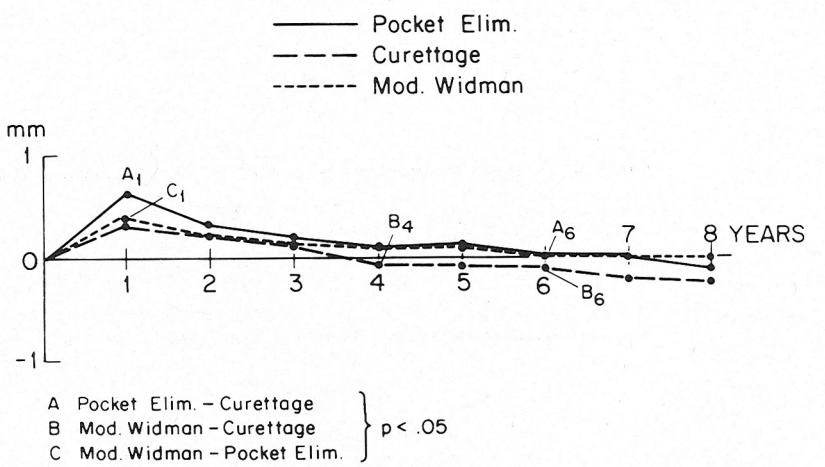

FIGURE 13. *Pocket reduction (patient means) for initial pockets 1–3 mm by treatment method.*

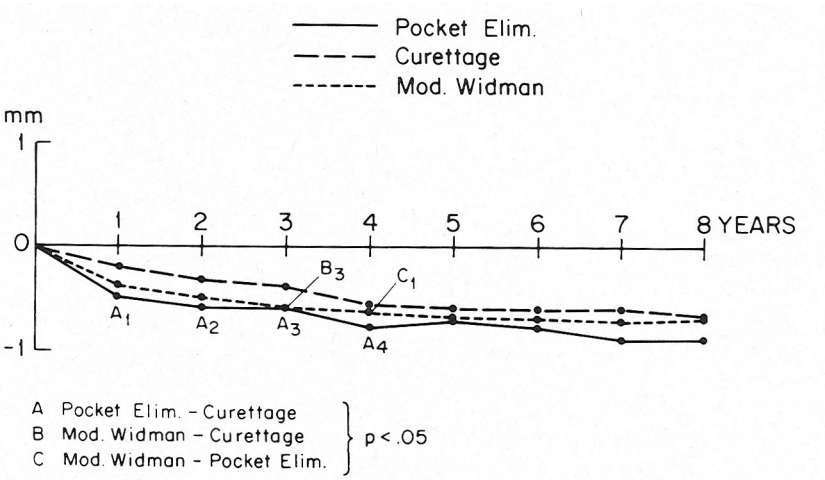

FIGURE 14. *Attachment change (patient means) for initial pockets 1–3 mm by treatment method.*

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Widman procedure appearing between the two extreme curves and being significantly different from pocket elimination only for year 4. There was a statistically significant loss of attachment over the 8 years following all three methods.

The reduction in depth over time of moderately deep pockets (4–6 mm) indicate significantly less reduction in depth following curettage than following the two other surgical procedures which are indistinguishable (Fig. 15). All three procedures resulted in a sustained significant reduction in pocket depth over 8 years.

The changes in attachment levels for the moderately deep pockets (4–6 mm), seen in Figure 16 indicate a slightly lesser gain of attachment following pocket elim-

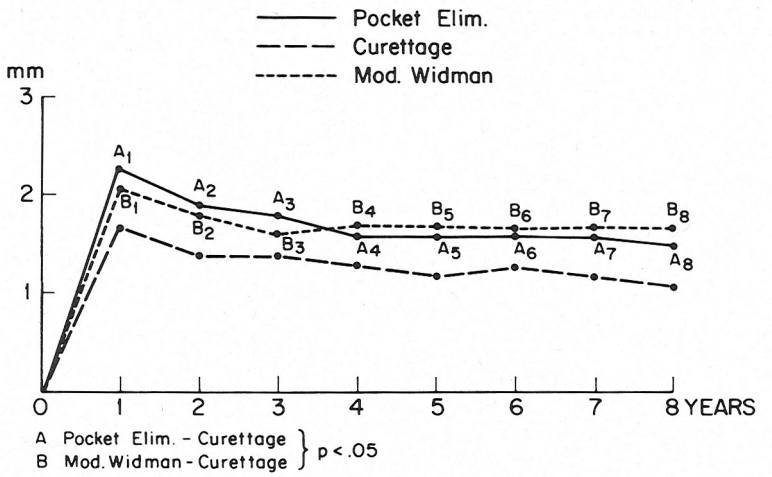

FIGURE 15. *Pocket reduction (patient means) for initial pockets 4–6 mm by treatment method.*

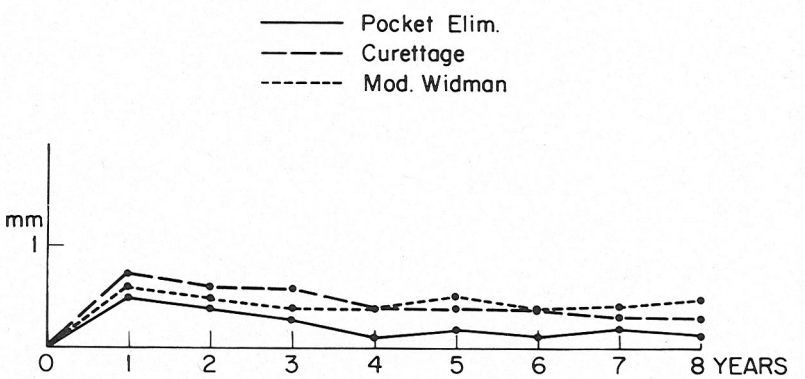

FIGURE 16. *Attachment change (patient means) for initial pockets 4–6 mm by treatment method.*

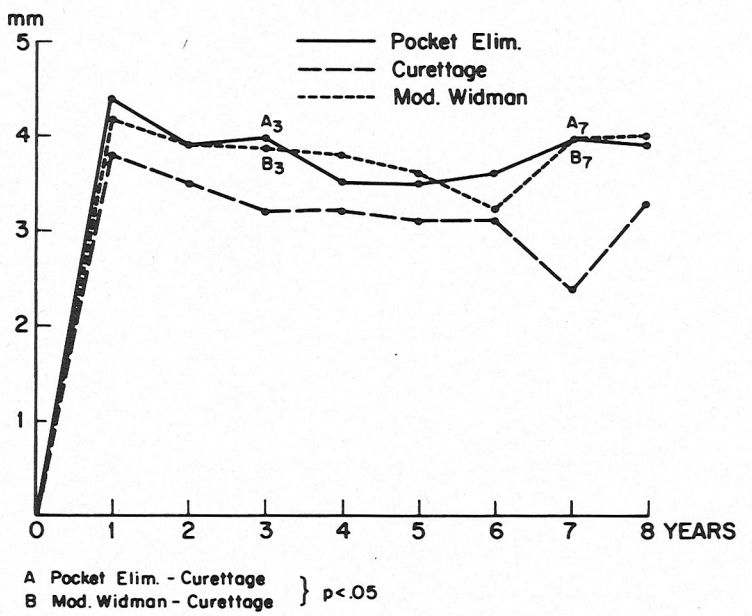

FIGURE 17. *Pocket reduction (patient means) for initial pockets 7–12 mm by treatment method.*

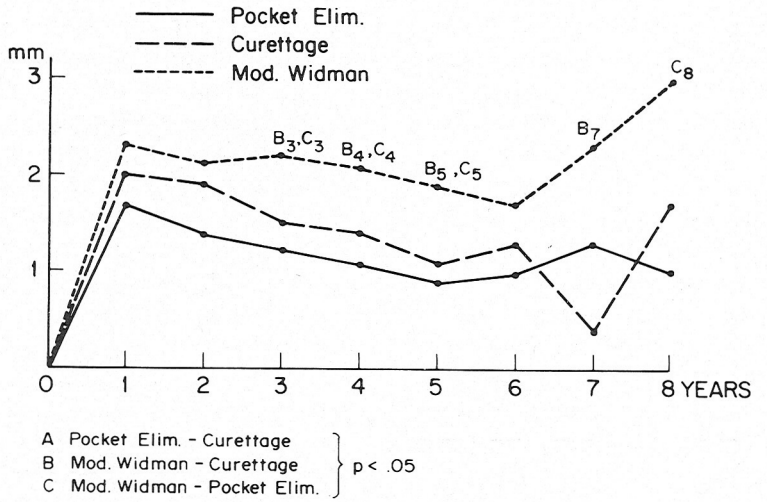

FIGURE 18. *Attachment change (patient means) for initial pockets 7–12 mm by treatment method.*

ination surgery than following the two other methods. There is a significant gain of attachment for the first 3 years following all three methods using the Student's *t* test. However, from year 4 to year 8 this gain is statistically significant only for the modified Widman and curettage (not for pocket elimination) procedures.

When the deep pockets (7–12 mm) are considered (Fig. 17), there evidently is less pocket reduction following curettage than following the other two methods, although in most instances these differences are not significant. The initial reduction was sustained well following all three methods with a significant reduction of pocket depth for all methods.

The attachment changes in the deep pockets (7–12 mm) seen in Figure 18 indicate a consistently greater gain in attachment following the modified Widman flap surgery than following the two other methods which show similar results. There is a significant gain in attachment 8 years after treatment for all methods except at year 7 for curettage.

SIGNIFICANCE

A. *Combined Effects of Three Modalities of Periodontal Therapy*

A number of somewhat confusing and partially misleading results reported in our studies,[1, 2, 3] may be more meaningful on the basis of the present method of data analysis. Furthermore, the present paper includes new and long term data not previously published.

The reported poor average results[3] following treatment of buccal pockets may be understood when it is considered that 85% of the buccal "pockets" actually were shallow crevices 1 to 3 mm deep (Fig. 1) and that such shallow crevices become deeper and lose attachment following treatment (Figs. 8 and 10). Even if the relatively few pockets on those surfaces showed favorable results, the average depth and attachment levels would be influenced much more by data from the numerous shallow nonpockets than from the much fewer true pockets. In order to assess what happened exclusively to the true pockets (4 mm and deeper), the data from the pockets had to be considered separately from the shallow crevices. It then became apparent that the responses to treatment depended on the initial pocket depth rather than being related to tooth surface (Fig. 4).

One of the most important findings in the present study is that the prognosis for treatment of pockets of equal depth is similar for all tooth surfaces.

The documentation of long term evidence (Figs. 8 and 9) indicating the initial pocket reduction 1 year after treatment was sustained regardless of initial pocket depth (excluding the shallow crevices that cannot be considered as pockets), should help to dispel the old myth that deep periodontal pockets commonly will return after treatment. Even more encouraging is the positive response of the attachment levels both in moderate and deep pockets (Fig. 10).

The grouping of the data in no pockets, moderately deep, and deep pockets, using patient means (Fig. 11) confirms a sustained statistically significant reduction in pocket depth both for the moderate (Class II) and the deep pockets (Class III) and shows that the reduction in depth was significantly greater for the deep than for the moderate pockets. There is no long term significant change for the nonpockets (Class I).

With the same arrangement of the data a statistically significant gain of attachment appears both for the moderate (Class II) and for the deep pockets (Class III), and with significantly more gain of attachment in the deep than in the moderate pockets. A significant loss of attachment is evident for the nonpockets (Class I). The fact that a statistically significant sustained gain of attachment is documented 8 years after the initial periodontal therapy should provide some comfort to persons who are worried that periodontal therapy may not even slow down the natural progress of untreated periodontitis. Allegedly, spontaneous regression and healing of pockets caused by abscesses occasionally may occur but

a significant mean reduction in pocket depth and gain of attachment in a sizeable population over 8 years would constitute a miracle according to present knowledge.[6]

The regrettable loss of periodontal support in no pocket areas (Class I) apparently occurred mainly as a result of the initial surgical therapy. This is not surprizing considering previous reports of loss following flap procedures.[7, 8] A tendency for loss of support at the top of a hemiseptum combined with regeneration at the deepest part also has been well documented by Rosling et al.[9, 11] Obviously these shallow crevices should not have been included in periodontal surgical procedures. However, the inclusion was unavoidable in order to gain access to adjacent pockets, and for elimination of bony defects when pocket elimination surgery was attempted.

The relationships between the penetrating tip of the periodontal probe and the histologic structures at the dentogingival junction may vary from one site to another, especially after periodontal therapy.[10] However, if a significant gain of clinical attachment is maintained over 8 years (as in the present study) every indication is that the periodontal treatment was successful, since it is known that in active periodontal disease the probing at least will penetrate to the connective tissue attachment.[14, 15] Evidence from similar studies elsewhere[9, 11, 12] are equally supportive of sustained pocket reduction and clinical and roentgenological gain of periodontal support following long term postoperative observations.

Obviously, reports of mean results with standard deviations included do not imply that every single pocket responded this favorably, and as a basis for prognosis it only indicates a 95% chance for a response within the borders of these confidence intervals.

B. *Significance of Treatment Modality*

The obvious message regarding (Class I, 1–3 mm) crevices is not to do surgical treatment or try to avoid inclusion of such areas in pocket elimination surgery. However, adjacent pockets and bony defects may dictate unavoidable inclusion of shallow crevices in order to achieve the surgical goals of the pocket therapy, and the loss is generally confined to the first year after the treatment thus, not jeopardizing the long term prognosis. It should be emphasized that results from clinical trials in periodontics based on mean results from all crevices and pockets[1-3] are not comparable to means including only true pockets,[12, 13] since inclusion of the shallow crevices with common loss of attachment will mask the gain of attachment in the true pockets, and give poorer results than studies confined to pockets.[13]

When the moderately deep pockets Class II (4–6 mm) are considered (Fig. 15), curettage is not as effective in pocket reduction as the two other procedures, although there was a highly significant reduction in pocket depth over 8 years following all three procedures. Thus, if maximal pocket reduction is accepted as the main objective of periodontal therapy, curettage would not be the treatment of choice for moderately deep pockets. Maybe surprizing to some, modified Widman surgery was fully as effective in long term reduction of pocket depth as pocket elimination surgery, and this occurred within a range of pockets where surgical pocket elimination usually can be carried out according to established surgical goals.[5] Most important for the prognosis after periodontal therapy however, is the long term maintenance of support for the teeth (Fig. 16). All three methods resulted in a significant gain in measurable clinical attachment over the first 3 postoperative years, and a sustained significant gain of attachment for all 8 years following curettage and modified Widman flap surgery (The gain after pocket elimination surgery was not significant for the last 5 years of follow up.). However, the differences among the three methods in gain of attachment was statistically significant only between subgingival curettage and pocket elimination for year 3, and from a clinical standpoint, the most important finding is that all three methods resulted in maintenance of periodontal support over 8 years.

It should be noted that the modified Widman flap surgery tended to be most effective both in pocket reduction and in preservation of attachment over the 8 years although the differences with the other methods were not consistently significant statistically. It also appears that the amount of pocket reduction is not necessarily important for maintenance of support for the teeth.

For the deep pockets (Class III, 7–12 mm), both modified Widman flap surgery and pocket elimination surgery were equally effective in sustained reduction of pocket depth (Fig. 17). Curettage was slightly less effective, but the differences were significant only for two of the eight intervals. It should be appreciated that the deep pockets often were not completely eliminated surgically due to anatomical, functional and esthetic limitations and three bony wall pockets were treated according to Prichard's[5] recommendations of not attempting complete elimination. All three modalities of treatment lead to a sustained highly significant reduction in pocket depth over 8 years compared with the original pocket depth.

All three methods also resulted in a sustained significant gain of attachment (Fig. 18). The relatively small number of deep pockets in the long term samples may count for the somewhat erratic behavior of the curves after year 6. For deep pockets the modified Widman surgery appears to be the treatment of choice both over pocket elimination and curettage although the differences are not always statistically significant.

The pocket reduction, especially following the modified Widman procedure, apparently is due to gain of attachment as well as recession of the free gingival margin.

The possible effect of furcation involvements on treatment results has not been included in this analysis and none of the included measurements were from the furcations. Although time spent on the various surgical

procedures was not recorded, it should be understood that subgingival curettage took as much time as any of the other surgical procedures.

Conclusions

After initial periodontal treatment and recall for prophylaxis every 3 months, over 8 years, the following conclusions can be made:

1. The magnitude of pocket reduction following periodontal therapy is positively related to the magnitude of the original pocket depth.
2. Changes in attachment levels also have a positive relationship to the original pocket depth.
3. All four probed surfaces of the teeth responded similarly to treatment when pockets of initial equal depth were compared.
4. Moderate and deep periodontal pockets can be reduced in depth and stay reduced over 8 years following subgingival curettage, modified Widman flap surgery, and pocket elimination surgery.
5. Attachment levels can be improved clinically both for moderate and deep pockets.
6. The pocket reduction for moderately deep pockets is greater following modified Widman procedures and pocket elimination surgery than following curettage but the total reduction is significant for all three methods.
7. Although all three methods result in gain of attachment in moderately deep pockets, the long term gain is significant only after curettage and modified Widman flap.
8. For deep pockets (7–12 mm), the pocket reduction also is significant and well sustained for all three methods. However, the reduction tends to be less following curettage than following the other two methods.
9. The significant gain of attachment in deep pockets (7–12 mm) was greatest over time following the modified Widman flap surgery.
10. Shallow gingival crevices (1–3 mm) tend to lose attachment the first year after periodontal surgery.

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