

A Long-Term Survey of Tooth Loss in 600 Treated Periodontal Patients

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THE MAIN GOAL of periodontal treatment is the retention of as many teeth as possible in health, function, and comfort. Since periodontal disease is chronic, the best means of evaluating the effectiveness of treatment is to observe large numbers of well-documented cases over a long period of time. It would be ideal to compare equal numbers of treated and untreated patients, similarly documented. However, the obligations of clinical practice preclude such an approach. In recent years, a number of short term (2 to 5 years) studies have tested the effects of various preventive techniques on the course of periodontal disease.¹⁻³ Specific methods of pocket elimination have been evaluated by Ramfjord⁴ and Lindhe⁵ in longitudinal studies. Oliver⁶ reported on tooth mortality in 422 patients averaging 10 years after active treatment. Similar evaluations of tooth mortality were carried out by Ross⁷ and Stern.⁸ This survey was undertaken to obtain data from treated patients maintained over a period of more than 15 years.

STUDY POPULATION

Six hundred patients who had been treated at least 15 years previously were recharted, photographed and radiographed. They were taken in consecutive order from the daily lists of a private practice. The first patients were recharted in 1966 and the last in 1971. Only patients with inadequate original documentation were rejected. Some patients had been treated many years before by Dr. Isador Hirschfeld, but most were originally cared for by the authors. All patients had been under periodic maintenance at 4- to 6-month intervals. The patients were predominantly Caucasian, from the middle economic levels, and generally well-motivated in their personal and professional dental care. There were twice as many females, 391 (65.2%), as males, 209 (34.8%), but there was no observable sex difference in the severity of disease at the original examination.

At the time of initial treatment, 498 (83%) of the

600 patients were below 50 years of age (Table 1), with 362 (60.3%) between the ages of 35 and 49. The average age of all patients was 42.

The distribution of patients according to years of maintenance can be seen in Table 2. Four patients originally had been treated more than 50 years before this survey, 19 more than 40 years before, and 60 more than 30 years before. The average duration of maintenance was 22 years and the median was 20 years.

At the original examination of all patients, and at reexamination, the periodontal condition was charted with graphic representations of pocket depth, degrees of mobility, gingival recession, and furcation involvement as described by Isador Hirschfeld.⁹ All patients charted after 1949 had pockets measured in millimeters.

A tooth was considered to have a questionable prognosis if it had one or more of the following:

Furcation involvement

A deep noneradicable pocket

Extensive alveolar bone loss

Marked mobility in conjunction with pocket depth (two or two-and-a-half degrees on a scale of three).

The patients were re-examined and the periodontal condition recorded in essentially the same manner during this survey.

The loss of teeth from periodontal causes over the study period was determined by comparing the initial and re-examination charting and reviewing the treatment history in the chart. Teeth lost during initial treatment were not counted as being lost during the survey period. If no specific information in the records indicated that a tooth was lost as the result of caries or periapical pathology, it was assumed that it was lost for periodontal reasons.

The severity of periodontal disease at the time of initial examination was divided into the following categories:

Early: pockets of 4 mm or less, generally with gingival inflammation and subgingival calculus deposits.

Intermediate: pockets of 4 to 7 mm present about a number of teeth.

Advanced: pockets deeper than 7 mm, furcation involvement of at least one tooth.

Of the 600 patients studied, 459 (76.5%) were initially classified as having advanced periodontal disease, while 99 (16.5%) had disease of intermediate severity. Only 42 patients (7.0%) exhibited early disease. In most individuals there were varying degrees of involvement of different teeth.

As the survey progressed, it became clear that the patients differed markedly in post-treatment course. Therefore, since the total tallies provided only limited

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TABLE 1. *Distribution of Sample by Age at Initial Treatment*

Age	Number of patients	Percent
12-19	9	1.5
20-29	53	8.9
30-39	182	30.3
40-49	254	42.3
50-59	88	14.7
60-73	14	2.3
Total	600	100.0

TABLE 2. *Distribution of Sample by Years of Maintenance*

Years of maintenance*	Number of patients	Percent
15-19	260	43.3
20-24	184	30.7
25-29	96	16.0
30-34	33	5.5
35-39	8	1.3
40-44	8	1.3
45-49	7	1.2
50-53	4	.7
Total	600	100.0

* Average, 22 years; median, 20 years.

and somewhat misleading information, the sample was divided on the basis of response to therapy into the following groups:

Well-maintained (WM) group, lost 0 to 3 teeth.

Downhill (D) group, lost 4 to 9 teeth.

Extreme Downhill (ED) group, lost 10 to 23 teeth.

On the basis of these groupings, the study population was distributed as follows:

Well-maintained	499	83.2%
Downhill	76	12.6%
Extreme Downhill	25	4.2%

TREATMENT OF PATIENTS

The older cases were treated primarily by subgingival scaling without local anesthetic, and selective grinding. Pocket depths in general were reduced but pockets were not always eradicated, even on single-rooted teeth. Depth certainly remained in most furcated areas. Pocket depths in the older cases were accepted while more vigorous attempts to eradicate pockets were made in the more recent patients. Many of the patients actively treated less than 25 years ago had surgical procedures performed according to techniques commonly used at that time. All patients had their active treatment before 1956, when many procedures used today were not practiced. Although definitive subgingival scaling had been performed in certain areas, many of the pockets had been treated by gingivectomy, osteoplasty, small flap or infrabony pocket procedures, root amputation or hemisection. However, root amputations were performed on only 17 teeth; all other furcation involvements were treated with the expecta-

tion of reducing pocket depth rather than eliminating pockets.

Fibrotic cases with little edema were treated surgically more frequently than edematous cases because the fibrotic gingiva would not be expected to shrink after subgingival scaling without local anesthesia. Pockets which extended to the buccal, palatal or lingual areas in addition to the interproximal surfaces were more likely to be treated surgically because in such cases gingivectomy could yield better results than in cases which were limited to interproximal destruction. On the other hand, pockets which were limited to labial or lingual surfaces of single-rooted teeth closed so predictably that they were more frequently treated by deep scaling only. Flap surgery was used on teeth with deep pockets which had abscessed or where there was inadequate access for a curet.

In many cases, areas were considered architecturally poor candidates for improvement by surgery and deep pockets were accepted. Most patients exhibited little change in residual crevice depth during the maintenance period, and therefore required no subsequent attempts to eliminate pockets during the maintenance phase.

No attempt was made to increase the amount of attached gingiva except in the case of the lower central incisor area, where some frenectomies and mucobuccal fold extensions were performed.

Since the cuspids and first bicuspids, the area of most present concern about adequate attached gingiva, generally did so well, free gingival grafting was rarely performed. This procedure came into use only during the maintenance period.

Recall Visits

At periodic recall visits, deep scaling was performed to remove subgingival calculus. Mobility and pocket depths were compared with earlier chartings and problem areas were retreated when necessary. The occlusion was checked and adjusted as indicated.

Oral Hygiene

Initially, all patients had been instructed in oral hygiene techniques, primarily the Isador Hirschfeld modification of the Charters Technique,¹⁰ using a hard natural-bristled three-row brush. During the maintenance phase, patients who were ineffective in using these techniques were taught either the Bass Technique,¹¹ a simple scrub technique using a soft-bristled brush, or use of the Broxodent. Dental floss and interdental cleansing and interproximal stimulating devices were also used but with less consistency. Some patients regularly presented with relatively heavy plaque and calculus on recall visits. In consequence, a number of them had localized gingivitis. Patients with these accumulations could be found in each of the

three response-to-therapy groups (Well-maintained, Downhill, and Extreme Downhill) though no tabulation was made.

Treatment of Mobility

Tooth mobility remained in many instances after initial treatment, although usually to a reduced degree, as indicated by notations made originally and in the later survey. Residual mobility did not seem to lead to further tooth loss. Increases of mobility were treated by selective grinding, and in certain cases by occlusal night guards or fixed splinting. Some teeth with moderate to severe mobility had such questionable prognoses that they were not included in extensive splints, and they were frequently maintained without additional support for many years.

RESULTS

At the completion of initial treatment most of the patients had relatively complete dentitions (Table 3). Seventy-five percent had more than 24 teeth and 29% had more than 28. The total number of teeth present in the 600 patients after initial treatment was 15,666. Over the 22-year average period of maintenance, 1,110 teeth (7.1%) were lost from periodontal causes and 202 teeth (1.2%) for other reasons. The type and percentages of teeth lost are shown in Table 4. Since a remarkable bilateral symmetry of periodontal disease and tooth loss has been apparent in this study and others,¹²⁻¹⁶ the counts for each tooth were combined for the right and left sides in Table 4.

Three hundred of the 499 patients in the Well-maintained group, half of the total sample, lost no teeth at all over the 22-year average period.

Since there were different patterns of tooth loss in the three response-to-therapy groups, they were studied separately as well as in combination to facilitate the interpretation of the findings. In the WM Group of 499 patients, 342 teeth (2.6% of the total number) were lost, for an average of 0.68 tooth per person (Table 5). Of these lost teeth, 79.5% initially had been marked

TABLE 4. Percentage of Each Tooth Type Lost During Maintenance Period

	Present following initial treatment	Number lost during maintenance period	Percent lost
8 8*	404	68	16.8
7 7	952	184	19.3
6 6	861	140	16.3
5 5	1,018	61	6.0
4 4	1,045	66	6.3
3 3	1,153	42	3.6
2 2	1,110	61	5.5
1 1†	1,127	60	5.3
1 1‡	1,162	73	6.3
2 2	1,182	39	3.4
3 3	1,192	9	.8
4 4	1,142	18	1.6
5 5	1,065	30	2.8
6 6	764	77	10.1
7 7	958	107	11.2
8 8§	532	75	14.1

* Maxillary third molars.

† Maxillary central incisors.

‡ Mandibular central incisors.

§ Mandibular third molars.

TABLE 5. Distribution of Teeth Lost According to Response Group

Prognosis of teeth	WM (499)	D (76)	ED (25)	Total (600)
Questionable	272	249	145	666
Favorable	70	186	188	444
Total	342	435	333	1,110
Average per patient	0.68	5.7	13.3	1.8

questionable. In the Downhill and Extreme Downhill groups, 22.7% and 55.4% of the total number of teeth were lost, respectively, with higher percentages of nonquestionable teeth lost.

The pattern of tooth loss was interesting. There was a great variation in mortality of the teeth in different positions in the arch and a remarkable symmetry of loss on the right and left sides. Table 6 lists the numbers of teeth originally present in each position in the arches of the WM group, and the teeth that were lost. A histogram of the data (Fig. 1) clearly demonstrates the loss according to tooth type of the various teeth in the arch. The dentitions of the WM group were relatively intact at the beginning of the study, with only the first and third molars missing in sizable numbers. Of special interest is the fact that over the 22-year average span of follow-up treatment, no cuspids were lost in the 499 patients of the WM group. Relatively few incisors and bicuspid were lost. The 76 patients of the D group showed essentially the same pattern of tooth loss (Table 7, Fig. 2) as the WM group, but there were relatively more incisors, maxillary cuspids, and bicuspid lost. The teeth most resist-

TABLE 3. Distribution of Sample by Number of Teeth Present at Completion of Initial Treatment

Number of teeth present*	Number of patients	Percent
29-32	174	29.0
25-28	276	46.0
21-24	83	13.8
16-20	42	7.0
11-15	17	2.8
6-10	8	1.4
Total	600	100.0

* Teeth present at examination, but removed during initial treatment are not included.

TABLE 6. Well-Maintained Group (499 patients) – Tooth Loss from Periodontal Disease, by Tooth Type

Tooth type	Initially present	Lost	Percent lost	Tooth type	Initially present	Lost	Percent lost
<u>8</u>	164	10	6.1	<u>8</u>	174	15	8.6
<u>7</u>	409	40	9.8	<u>7</u>	402	51	14.9
<u>6</u>	364	25	6.9	<u>6</u>	373	29	7.7
<u>5</u>	431	7	1.6	<u>5</u>	439	10	2.3
<u>4</u>	442	8	1.8	<u>4</u>	443	4	0.9
<u>3</u>	481	0	.0	<u>3</u>	482	0	.0
<u>2</u>	467	1	0.2	<u>2</u>	465	6	1.3
<u>1</u>	474	2	0.4	<u>1</u>	471	6	1.3
<u>1</u>	482	7	1.5	<u>1</u>	485	5	1.0
<u>2</u>	498	4	0.8	<u>2</u>	490	2	0.4
<u>3</u>	497	0	0.0	<u>3</u>	495	0	.0
<u>4</u>	472	5	1.0	<u>4</u>	482	1	0.2
<u>5</u>	439	5	1.1	<u>5</u>	450	4	0.9
<u>6</u>	327	18	5.5	<u>6</u>	318	13	4.1
<u>7</u>	402	17	4.2	<u>7</u>	406	22	5.4
<u>8</u>	225	8	3.5	<u>8</u>	215	17	7.9

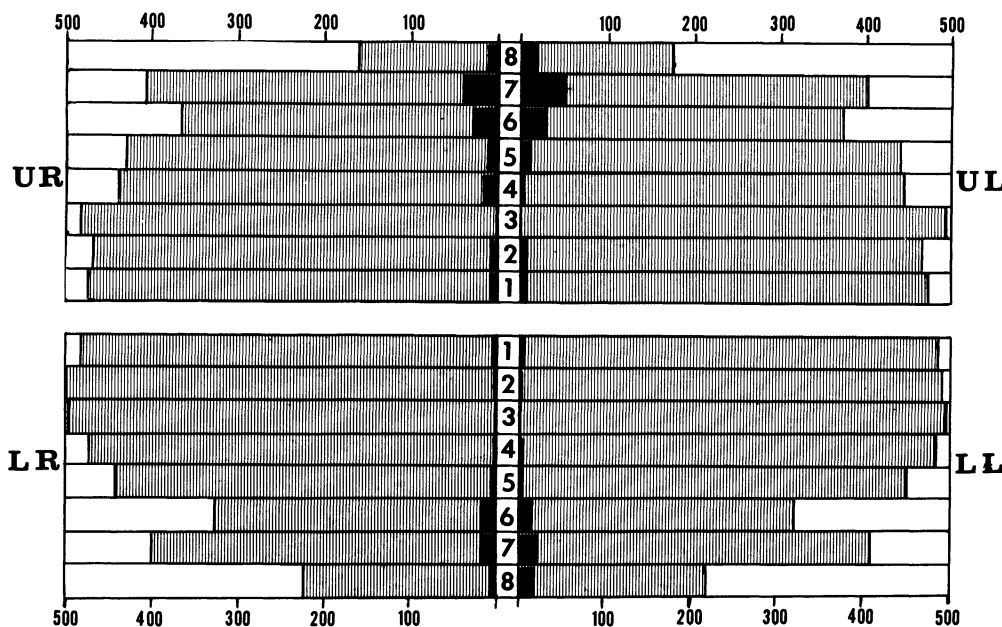


FIGURE 1. Teeth in the Well-maintained group that were present initially but were lost during the study period.

ant to loss were still the mandibular cuspids and first bicuspid.

In the Extreme Downhill group of 25 cases, tooth loss was less selective (Table 8, Fig. 3). Most of the maxillary teeth were similar in frequency of loss. Though most of the mandibular molars and incisors were lost, the relative resistance of the mandibular cuspids and first bicuspid was apparent even in this group.

Table 9 summarizes the relative frequency of tooth loss in the total sample and in each response group, in descending order.

Loss of Questionable Teeth

As Table 5 indicates in the WM group of 499 patients 342 teeth were lost (0.68 per patient). Of

these lost teeth 79.5% (272 teeth) originally had been indicated as having questionable prognoses because of either furcation involvement, severe mobility, or 7- to 10-mm pocket depths (depending upon root length). Only 70 of the teeth lost (20.5%) had been considered to have favorable prognoses.

In the Downhill group, where an average 5.7 teeth per patient had been lost, 57.2% of the teeth originally had been considered questionable. In the Extreme Downhill group, where an average 13.3 teeth per patient had been lost, only 43.5% originally had been marked questionable.

A closer analysis of the fate of the 2,139 teeth originally marked questionable in the 600 patients indicated that although 666 (31.1%) were lost, each response group provided a different pattern (Table

10). In the 499 patients of the WM group only 17.1 of the questionable teeth were lost whereas in the Extreme Downhill group almost all were lost.

Loss of Teeth with Furcation Involvement

There were 867 maxillary and 597 mandibular teeth with furcation involvement in the total sample (Table 11). Of these, 284 maxillary and 176 mandibular teeth were lost.

In the WM group only 18.5% of the maxillary first and mandibular first and second molars with furcation involvements were lost. However, 23.6% of the maxillary second molars were lost (Fig. 4). It was apparent that while most of the molars lost in the WM group had furcation involvements originally, only 19.3% of the molars which did have such involvement were lost.

Proportionately more third molars were lost. However, there were manifold possible causes for their extraction (prosthetic reasons, extrusion) which might have been associated with the periodontal disease, but were not primarily periodontal. The proportion of furcated teeth lost was much greater in the Downhill and Extreme Downhill groups.

Loss of Nonfurcated Questionable Teeth

A total of 675 single-rooted teeth and molars without furcations were originally classified as having questionable prognoses. Of these 204 (30.2%) were lost. An examination of individual tooth loss in each response group (Table 12) shows that while 37 cuspids in the WM group originally had so much destruction that they were marked questionable, not one was lost. In fact,

TABLE 7. Downhill Group (76 patients)—Tooth Loss from Periodontal Disease, by Tooth Type

Tooth type	Initially present	Lost	Percent lost	Tooth type	Initially present	Lost	Percent lost
8]	26	14	53.8	┌8	29	20	68.9
7]	54	31	57.4	┌7	54	31	57.4
6]	51	29	56.8	┌6	47	31	65.9
5]	61	11	18.0	┌5	53	8	15.0
4]	62	15	24.2	┌4	60	14	23.3
3]	71	10	14.1	┌3	71	7	9.8
2]	66	11	16.6	┌2	68	13	19.1
1]	66	10	15.1	┌1	68	12	17.6
1]	75	16	21.3	┌1	75	15	20.0
2]	73	8	10.9	┌2	75	8	10.6
3]	75	2	2.6	┌3	76	2	2.6
4]	73	3	4.1	┌4	69	0	.0
5]	66	6	9.0	┌5	65	5	7.6
6]	47	15	31.9	┌6	45	9	20.0
7]	58	20	34.5	┌7	55	24	43.6
8]	36	18	50.0	┌8	36	17	47.3

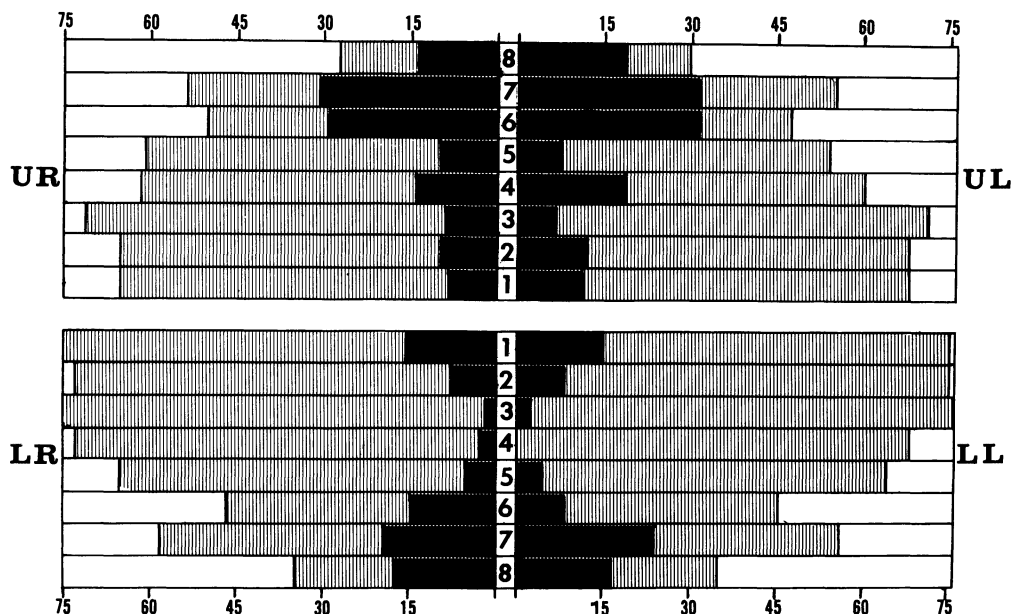


FIGURE 2. Teeth in the Downhill group that were present initially but were lost during the study period.

TABLE 8. Extreme Downhill Group (25 patients) – Tooth Loss from Periodontal Disease, by Tooth Type

Tooth type	Initially present	Lost	Percent lost	Tooth type	Initially present	Lost	Percent lost
8 _l	5	4	80.0	8 _r	6	5	83.3
7 _l	16	16	100.0	7 _r	17	15	88.2
6 _l	13	13	100.0	6 _r	13	13	100.0
5 _l	20	15	75.0	5 _r	19	10	52.6
4 _l	20	14	70.0	4 _r	18	11	61.1
3 _l	24	13	54.1	3 _r	24	12	50.0
2 _l	23	16	69.6	2 _r	21	14	66.6
1 _l	24	16	66.6	1 _r	24	14	58.4
1 _l	23	14	60.9	1 _r	22	16	72.7
2 _l	23	8	34.8	2 _r	23	9	39.1
3 _l	23	2	8.7	3 _r	25	3	12.0
4 _l	23	5	21.7	4 _r	23	4	17.4
5 _l	22	7	31.8	5 _r	23	3	13.0
6 _l	13	10	76.9	6 _r	14	12	85.7
7 _l	18	11	61.1	7 _r	19	13	68.4
8 _l	8	6	75.0	8 _r	12	9	75.0

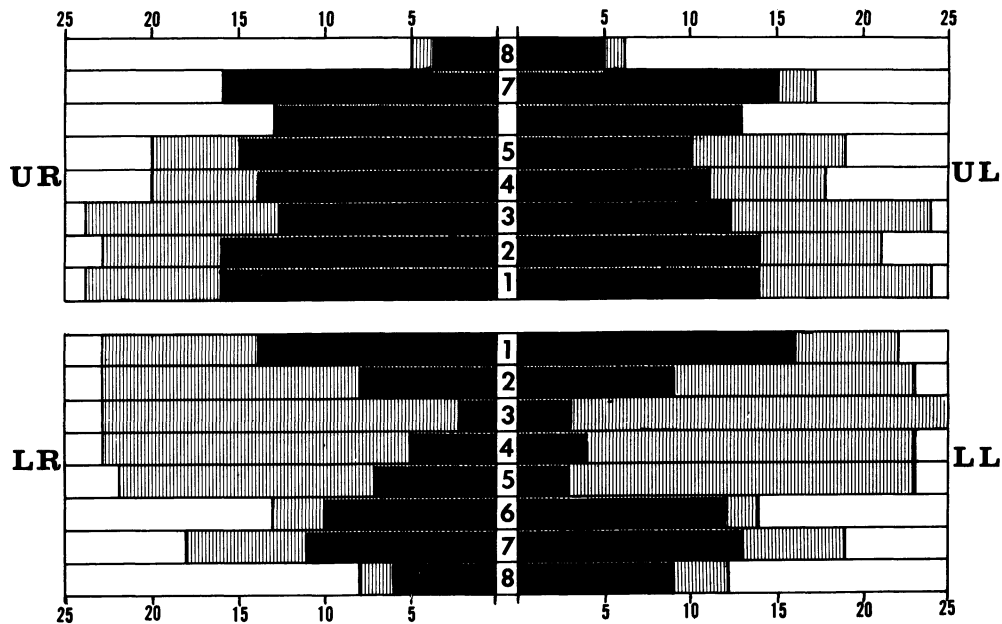


FIGURE 3. Teeth in the Extreme Downhill group that were present initially but were lost during the study period.

TABLE 9. Loss of Individual Teeth in Decreasing Order of Frequency

All patients	WM	D	ED
Maxillary second molar	1	2	2
Maxillary first molar	2	1	1
Mandibular second molar	3	3	7
Mandibular first molar	4	4	3
Maxillary second bicuspid	5	8	8
Mandibular central incisor	6	6	5
Maxillary first bicuspid	7	5	6
Mandibular second bicuspid	8	12	12
Maxillary central incisor	9	9	9
Maxillary lateral incisor	10	7	4
Mandibular first bicuspid	11	14	13
Mandibular lateral incisor	12	10	11
Maxillary cuspid	13	11	10
Mandibular cuspid	14	13	14

only 11% of the questionable nonfurcated teeth were lost in this group, while 55% were lost in the D group and 92.1% in the ED group. Questionable maxillary incisors were more resistant to loss in the WM group than mandibular incisors (Fig. 5). Only 8.2% of the maxillary incisors and 17.2% of the mandibular incisors originally marked questionable were lost.

Surgical Intervention

Of the entire group of 600 patients, 230 (39.3%) had surgery performed (Table 13). Approximately one-half of these had one area treated, and one-quarter had two areas. In addition to surgery performed during

TABLE 10. Loss of Teeth Originally Marked Questionable By Response Group

Questionable teeth	WM (499)	D (76)	ED (25)	Total (600 patients)
Initially present	1592	385	164	2141
Lost	272	249	145	666
Percent lost	17.1%	64.7%	88.4%	31.3%

TABLE 11. Teeth With Furcation Involvement Lost, by Response Group

Tooth type	WM (499)		D (76)		ED (25)		Total Group	
	Lost/present	Percent	Lost/present	Percent	Lost/present	Percent	Lost/present	Percent
8 8	15/48	31.2	17/20	85.0	3/4	75.0	35/72	48.6
7 7	76/322	23.6	46/60	76.7	19/20	95.0	141/402	35.1
6 6	50/304	16.5	42/64	65.6	15/16	93.7	107/384	27.9
4 4	1/8	12.5	0/1	00.0	0/0	00.0	1/9	11.1
6 6	27/176	15.3	16/27	59.2	16/19	84.2	59/222	26.5
7 7	34/211	16.1	27/43	62.9	16/23	69.5	77/277	27.8
8 8	17/71	23.9	17/21	80.9	6/6	100.0	40/98	40.8
Total	220/1140	19.3	165/236	69.9	75/88	84.4	460/1464	31.4

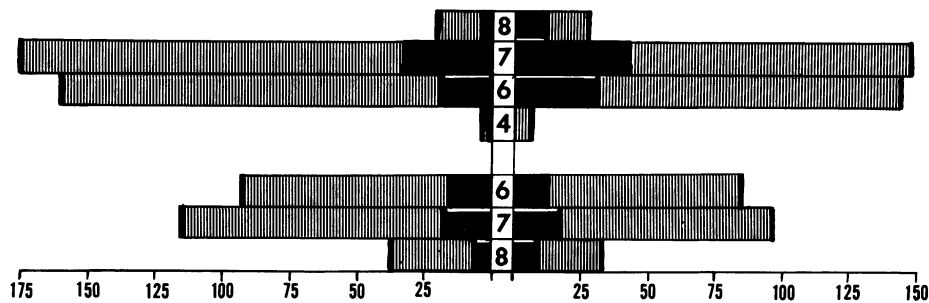


FIGURE 4. Teeth in the Well-maintained group that had furcation involvement initially and were lost during the study period.

TABLE 12. Nonfurcated Questionable Teeth Lost

Tooth type	WM (499)		D (76)		ED (25)		Total Group (600)	
	Lost/present	Percent	Lost/present	Percent	Lost/present	Percent	Lost/present	Percent
┌ Incisors	10/122	8.2	21/47	44.7	36/37	97.3	67/206	32.5
└ Incisors	11/64	17.2	20/30	66.7	4/7	57.1	35/101	34.7
└ Cuspids	0/37	0.0	7/17	41.2	13/13	100.0	20/67	29.9
┌ Bicuspid	13/113	11.5	22/34	64.7	17/18	94.4	52/165	31.5
└ Bicuspid	7/48	14.6	6/13	46.1	0/1	0.0	13/62	21.0
Molars	11/66	16.7	6/8	75.0	0/0	0.0	17/74	23.0
Totals	52/450	11.6	82/149	55.0	70/76	92.1	204/675	30.2

the active treatment, some patients had isolated surgical procedures during the follow-up period because of the formation of new or deepening pockets or gingival regrowth after previous surgery.

In the WM group 180 of the 499 patients (36.1%) had surgical procedures, usually in only one area. *One-half* of the patients in both Downhill groups had surgery performed and more areas were done per patient. The surgery for 97 patients in the three groups was performed during the active treatment only, for 88 patients in the maintenance period only, and for 28 patients during both periods (Table 14). Patients in the WM group had nearly the same proportions of surgical

procedures in the active and maintenance periods. However, patients in the other two groups had considerably more done during the maintenance phase because of the unsatisfactory progress of their cases.

In the Well Maintained group, 5 maxillary and 38 mandibular areas were twice treated surgically; in the Downhill group, 9 maxillary and 17 mandibular areas were operated twice; and in the Extreme Downhill group, 6 maxillary and 27 mandibular areas were operated twice. Combining the data for the three groups gives a total of 20 maxillary and 82 mandibular areas, or a grand total of 102 areas that received two surgical procedures. Interestingly, in all groups, four

times as many repeated procedures were done in the mandibular arch as in the maxilla.

It is important to note that all groups had the same surgical experience during the initial treatment, with approximately 16% of the patients in each group having some surgery. It can be inferred from this that all groups had similar periodontal involvement at the onset.

The numbers of teeth in various positions in the arch which were lost even though surgery was performed are shown in Table 15 and Figure 6. The degree of difference in response in the total sample, the WM, and the ED groups can be visualized in Figures 7 and 8. In all groups, the mandibular cuspids and bicusps showed greater survival after surgery than any other teeth.

Fixed and Removable Prostheses

Many of the patients were treated initially before extensive splinting was widely used. Since most of the patients were being maintained very well, there was usually no indication for introducing such splints, especially when the dentition was fairly complete.

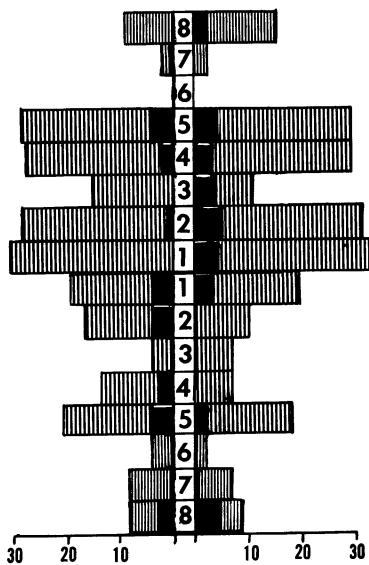


FIGURE 5. Questionable nonfurcated teeth in the Well-maintained group lost during the study period.

At the time of re-examination there were, in the 988 arches of the 499 patients in the WM group, 228 bridges, some of them with a double abutment, which were not considered extensive splints (Table 16). There were 72 arches with limited splints, usually two teeth, most often used to support a removable partial denture. There were 65 arches with extensive splinting, usually involving all the remaining teeth, but this was generally done only when relatively few posterior teeth were left. Most such splints were combined with partial dentures. Some of these restorations were present initially and others were made during and after initial treatment.

Patients in the D group were doing less well and it was felt that much more had to be done to stabilize the teeth. In addition, since many teeth were lost, new replacements were required and, in the light of their past history, it was usually decided to splint extensively rather than risk inadequate support for the replacements. One out of five arches in the D group had extensive splinting.

In the ED group, 18 arches out of 50 had extensive splints and 12 had complete dentures. Only 20 arches then, had limited splinting or none and in the latter cases the arches usually were not splinted because the teeth were too periodontally involved to warrant it.

The removable dentures used to replace the teeth lost after treatment as well as those originally missing are listed in Table 17. In the WM group of 998 arches, there were 48 completely tooth-borne four-clasp dentures, of which only 9 had limited splints for one or two abutments. Half of the distal extension partial

TABLE 14. Patients Having Surgery During Initial Treatment and Maintenance Phase

	WM (499)	D (76)	ED (25)	Total group (600)
Initial treatment	81	12	4	97
Maintenance only	63	20	5	88
Both initial and maintenance	21	4	3	28
Root amputations	15	1	1	17
	180	37	13	230

TABLE 13. Surgical Procedures Performed Per Patient, By Response Group

Number of procedures	WM (499)	Percent	D (76)	Percent	ED (25)	Percent	Total group (600)	Percent
1	98	19.6	21	27.6	2	8.0	121	20.2
2	40	8.0	7	9.2	3	12.0	50	8.3
3	26	5.2	2	2.6	1	4.0	29	4.8
4	12	2.4	5	6.5	1	4.0	18	3.0
5	4	0.8	1	1.3	1	4.0	6	1.0
6			1	1.3	3	12.0	4	1.5
7					1	4.0	1	.2
8			1	1.3			1	.2
	180	36.0	38	49.8	12	48.0	230	39.2

TABLE 15. Teeth Lost After Surgical Treatment

Tooth type	WM (499)		D (76)		ED (25)		Total Group (600)		
	Lost/treated	Percent	Lost/treated	Percent	Lost/treated	Percent	Lost/treated	Percent	
Maxillary	Molars	52/244	21.3	36/56	64.2	17/19	89.5	77/316	24.4
	Bicuspid	6/150	4.0	12/46	26.1	18/22	81.8	36/218	16.5
	Cuspids	0/58	0.0	0/14	0.0	5/8	62.5	5/80	6.2
	Incisors	1/58	1.7	2/14	14.3	6/6	100.0	9/78	11.5
Mandibular	Incisors	2/33	6.1	6/17	35.3	12/16	75.0	20/68	29.4
	Cuspids	0/27	0.0	0/12	0.0	1/11	9.1	1/50	2.0
	Bicuspid	0/84	0.0	1/40	2.5	3/21	14.3	4/145	2.7
	Molars	15/144	13.1	15/35	42.9	14/17	82.4	43/167	25.7
Totals	76/533	14.2	72/234	30.8	76/120	63.3	195/1034	18.8	

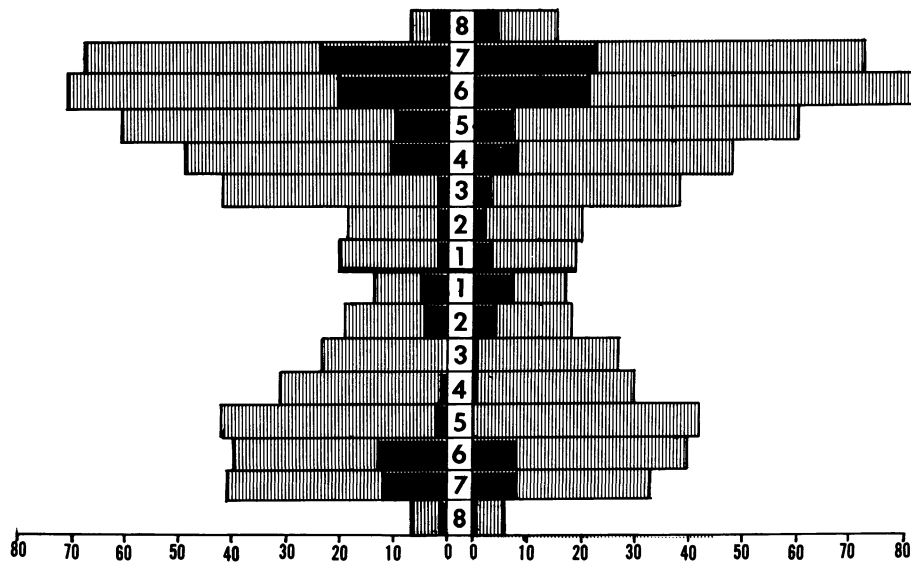


FIGURE 6. Teeth in all three groups that were treated surgically and subsequently were lost.

dentures, usually made before splinting was done routinely, survived without splinting or crowned abutments. Thirty-one small Nesbitt bridges were successfully used, mostly in the older cases.

DISCUSSION

The data analyzed in this study are definitive in that there was no question as to whether or not a tooth was lost, but it is at the same time an admittedly gross measure of success or failure of treatment. However, even with those limitations, much can be learned by analyzing the patterns of tooth loss and by comparing the results with those of other studies.

Significance of Sample Size

There apparently is a definite pattern of tooth loss in periodontal disease. After the first 165 cases had been recharted, tallies were made. Then, when 420 cases had been surveyed, the results were collated again. It is interesting that tallies made at the end of the survey, of all 600 patients, show practically the same distribution of tooth loss, the same proportion of cases in each group, and the same experience with furcations and questionable teeth as in the smaller tallies.

Patterns of Tooth Loss Compared to Patterns of Bone Destruction

In 1942 Miller and Seidler¹² examined the radiographs of 500 clinic periodontal patients and rated the alveolar support of each tooth on a 1 to 5 scale. The sum of the scores for all the maxillary left second bicuspid, for example, was divided by the number of maxillary left second bicuspid present in the sample to obtain an average score for that tooth. The authors found a bilateral symmetry of the average scores. The pattern of distribution of bone loss they reported was very similar to the pattern of tooth loss observed in our study.

In a detailed study and computer analysis of 516 clinic patients at Columbia, Wasserman and Geiger¹³⁻¹⁴ scored, among many other things, gingival inflammation and periodontal destruction around each tooth. They also commented on the striking symmetry of distribution of both gingival inflammation and periodontal destruction. The severity as well as the incidence of the destruction showed bilateral symmetry.

The presence of disease in their study was listed in descending order of frequency. Their list of incidence

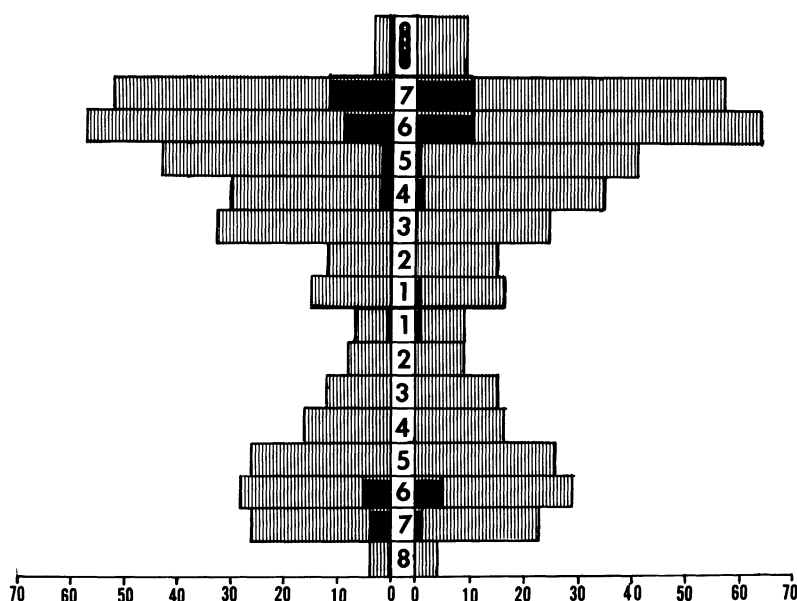


FIGURE 7. Teeth in the Well-maintained group that were treated surgically and subsequently lost.

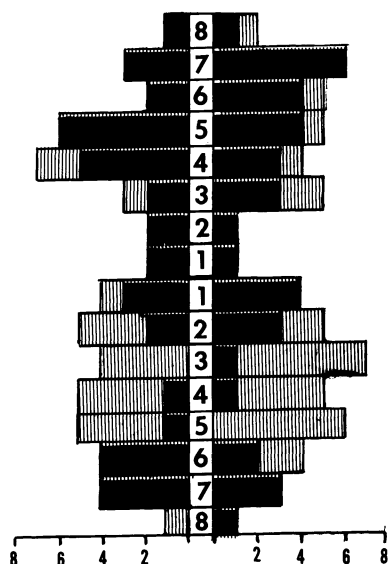


FIGURE 8. Teeth in the Extreme Downhill group that were treated surgically and subsequently were lost.

of periodontal destruction is in almost exactly the same order as the list and graph of teeth lost in our WM group, which represented 83.2% of our total sample.

The bilateral pattern mentioned may not be present in each individual patient, but in a study of groups it becomes quite clear. Bossert and Marks¹⁵ examined 12,800 employees of the Metropolitan Life Insurance Company and found definite and symmetrical patterns of periodontal destruction, with significant differences among teeth in different positions. In an examination of 400 Iraqi and British children, Wade¹⁶ found that the incidence of gingival disease was so symmetrical bilaterally that it was necessary to examine only half the mouth.

Some teeth are more susceptible than others to periodontal disease and loss. Maxillary molars have the worst prognosis and lower cuspids the best, with the

others ranging between the two extremes. The explanation for that differential is still unclear. Many factors may be involved, such as anatomic characteristics of each tooth and its housing, forces applied, local variations in the bacterial flora, and genetic keying. One is forced to speculate further about other causes since the effects on the various teeth are so dramatically different. This observation is all the more interesting since metabolic and other systemic etiologic factors might be expected to affect all teeth equally.

The variation in tooth mortality may have a bearing on prognosis and treatment planning. For example the large number of maxillary second molars with furcation involvement lost could be related to the prognosis of such a tooth as a bridge abutment and might influence the design of a restoration involving that tooth. Surgical treatment might be more aggressive in an attempt to modify the poor prognosis of this situation. From the fact that only 16.6% of the lower molars with furcation involvement were lost in the WM group of 499 patients, one might infer that such teeth are safer to retain and use as abutments than was heretofore believed.

Of the 387 furcated mandibular molars in the WM group, 246 were retained over the average 22-year period. In the other two groups, only 37 of the 112 furcated mandibular molars survived. It is apparent then, that the prognosis of "questionable" teeth depends on the general trend of the case as well as on the extent and configuration of the periodontal destruction at the time of examination.

An interesting relationship was noted between tooth loss and gingival inflammation associated with plaque retention. A bare majority of the WM group managed their oral hygiene procedures effectively. Some came in with apparently plaque-free teeth and said they hardly brushed. Others achieved their cleanliness with a great deal of work. However, many patients came in

TABLE 16. Splinting In Individual Dental Arches

	WM (998)		D (152)		ED (50)		Total (1200)	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Extensive	65	6.5	30	19.7	18	36.0	113	9.4
Limited	72	7.2	30	19.7	5	10.0	107	8.9
Bridges	288	22.8	24	15.8	0	00.0	252	21.0

TABLE 17. Dentures In Individual Dental Arches

	WM (998)		D (152)		ED (50)		Total (1200)	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Complete dentures	7	0.7	9	5.9	12	24.0	28	2.3
Partial dentures	48	4.8	14	9.2	6	12.0	68	5.7
Partial dentures*	9	0.9	2	1.3	1	2.0	12	1.0
Distal extension dentures	105	10.5	54	35.5	23	46.0	182	15.2
Distal extension dentures*	55	55.1	31	20.4	13	26.0	99	8.3
Nesbitt bridges	31	3.1	4	2.6	0	0.0	35	2.9

* Limited Splinted Abutments.

regularly with considerable plaque and gingival inflammation, and yet did not lose bone support or teeth over the many years. Some patients kept certain areas clean, but seemed unable to deal with other areas which had gingival inflammation but often little bone loss.

In the Wasserman and Geiger study,¹⁴ patients with periodontal breakdown had gingival inflammation more often than patients without breakdown, but the teeth with the most inflammation and the teeth with the most breakdown did not necessarily correspond. When individual teeth were listed in decreasing order of inflammation and periodontal destruction, there was no correlation between the two lists. For instance, the greatest inflammation was found about the mandibular central incisors, lateral incisors, and cuspids. The mandibular central incisors were eighth on the list of destruction, the lateral incisors ninth, and the cuspids 15th. Most of those at the top of the destruction list were at the bottom of the inflammation list.

Wasserman and Geiger concluded: "Clinically evident inflammatory changes of the gingiva, though considered a precursor of periodontal destruction, may not necessarily evolve into a periodontal destructive lesion."¹⁴ Our survey seems to bear this out.

Response Groupings

The division of the study population into the three "response groups (WM, D, and ED), though based on arbitrary criteria, nevertheless implied markedly different patterns of resistance to extension of the disease by the individuals in the study.

All response groups initially had nearly equal distributions of advanced periodontal disease. Questionable teeth were also evenly distributed among the groups, which indicated a similar initial susceptibility to the disease for all groups. The only apparent variable was the difference in prior loss of the first molars. In the WM group, for example, 28% of the maxillary and

35% of the mandibular first molars had been lost prior to treatment, while in the ED group 48% in each arch had been lost. However, with relatively similar initial treatment, the course of the disease was dramatically different when the WM group was compared to the ED group.

The disease process often followed a cyclically active pattern. Irregularly spaced cycles of destructive activity were evident in all response groups, even the WM group. Several advanced cases responded very well to treatment, with no teeth being lost for over 20 years, and then suffered rapid periodontal destruction, with the loss of many teeth. Many of the Downhill and Extreme Downhill cases remained stable for years, with periods of destruction occurring sporadically.

During these destructive phases, in all groups, many teeth which initially had been either normal or nearly so, would undergo active periodontal destruction. Regular maintenance treatment did not prevent loss of 70 originally normal or slightly diseased teeth in the WM group. This represented 20.5% of all teeth lost in this most resistant group.

Many patients in the WM group kept their teeth despite gingival inflammation, inadequate brushing, a degree of occlusal trauma, tooth mobility, residual crevice depth, and removable dentures which did not have what is generally considered adequate support. For patients with similar problems in the other two groups, especially the ED group, it seems that elimination of pockets by surgery, extensive splinting and improved hygiene only delayed the loss of teeth. However, in the great majority of cases surveyed, simple but thorough treatment in the form of subgingival scaling, occlusal adjustment, and fair to good home care seemed to reduce tooth loss. Socransky¹⁷ has emphasized the importance of particular organisms resident in the gingival sulcus as primary mediators of periodontal destruction. According to Listgarten,¹⁸

deep scaling disturbs this well organized ecosystem with lasting changes in resident bacteria. Thus it is possible that periodic recall visits wherein deep pockets are scaled, could provide a longer lasting beneficial effect than was supposed previously.

The question often has been posed as to whether periodontal treatment prolongs the life of the tooth. In the absence of a large group of control patients in the study population, a search was made for a means of substantiating the clinical impression that treatment is effective. One such method was to compare our results with the relative numbers of teeth missing at various ages, as measured in a large cross-sectional study of periodontal disease.

The data from one such study, a cross-sectional survey of 1,187 people by C. D. Marshall-Day et al.¹⁷ in 1947, were adjusted and compared to our population. In the Marshall-Day study the loss of most teeth between ages 30 and 60 was attributed to periodontal disease. Since only 7% of the patients had had any kind of periodontal treatment, the sample can be considered basically untreated. In that study the 40 to 45 age group averaged 10 teeth missing from all causes, while the 60 to 65 group were missing 20, a difference of 10 teeth. In comparison, at average age 42 our patients were missing 5.9 teeth and at average age 64 they were missing 8.1 teeth, a difference of 2.2 teeth. The loss of 2.2 teeth by our patients during the 22 years of observation compares very favorably with the loss of 10 teeth between the 40 to 45 and 60 to 65 age groups described by Marshall-Day.

At average age 64 our treated patients had lost only 25% of their teeth as compared to 60% in the comparable age group in the Marshall-Day study.

It would be dangerous to derive a firm conclusion by comparing a longitudinal study with a cross-sectional survey involving different people in each age group. In addition, differences in the populations which could not be evaluated, such as socioeconomic status, would be reflected in the levels of tooth mortality. However, since 5 times as many teeth were lost in the untreated Marshall-Day group during the age span when most tooth loss is caused by periodontal disease, perhaps an indication can be inferred.

When the results of this study were compared with those of a similar one by Oliver⁶ some of the differences served to highlight the difficulties inherent in this type of practice analysis. In his survey the period of treatment and maintenance ranged from 5 to 17 years, with an average of 10.1 years, as compared to a range of 15 to 53 years, with an average of 22 years, that is reported here. The rate of tooth loss for periodontal reasons in the Oliver study was 1.6% as compared to 7.1% for our group as a whole. Of course the tooth loss in our WM group of 499 patients was only 2.6%. The additional years of maintenance in our group probably played an important role in the larger per-

centage of questionable teeth lost. In addition, teeth originally considered to have favorable prognoses had greater opportunity to undergo new or increased periodontal destruction.

The proportion of teeth with furcation involvement at the onset of maintenance, 9.3% in this study, was nearly twice the percentage of furcated teeth which were deemed treatable and therefore maintained by Oliver. In view of such differences in criteria for tooth retention, subsequent tooth loss would be considerably greater in our study. Though figures for nonfurcated questionable teeth were not given by Oliver, it is probable that in this category as well, fewer teeth were retained at the onset.

SUMMARY

1. Six hundred patients in a private periodontal practice were reexamined an average of 22 years after their active treatment and the patterns of tooth loss were observed.

2. During the post-treatment period, 300 patients had lost no teeth from periodontal disease, 199 had lost one to three teeth, 76 had lost 4 to 9 teeth and 25 had lost 10 to 23 teeth.

3. Of 2,139 teeth that originally had been considered of questionable prognosis, 666 were lost. Of these, 394 were lost by one-sixth of the patients and only 272 by the other five-sixths.

4. Of 1,464 teeth which originally had furcation involvements, 460 were lost, 240 of them by one-sixth of the patients who deteriorated most.

5. The mortality of teeth which were treated with periodontal surgery was compared with that of teeth which did not have surgery. Tooth retention seemed more closely related to the case type than the surgery performed.

6. In general, periodontal disease is bilaterally symmetrical and there is a predictable order of likelihood of tooth loss according to position in the arch.

ACKNOWLEDGMENTS

The authors wish to thank Drs. Alan Lubarr and Alan A. Winter for their help in collating certain of the data.

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Abstracts

EFFECT OF MONTHLY PROFESSIONAL MECHANICAL TOOTH CLEANING ON PERIODONTAL HEALTH IN ADULTS

Glavind, L.

J Clin Periodont 4: 100, May, 1977.

Monthly professional mechanical tooth cleanings were administered to 28 periodontal recall patients to study the factors determining the effectiveness of comprehensive dental prophylaxis programs. The plaque and gingival indices were recorded for both the experimental and control teeth 1 month prior to the study, at the start, and 4, 8, and 12 months later. Teeth were randomly selected by the split mouth cross-over method and cleaned of plaque and calculus initially. Only the experimental teeth were thoroughly cleaned monthly thereafter. During the study a high standard of oral hygiene and oral health was observed for both groups. These results were similar to the scores obtained following the initial tooth cleaning and the preexperimental period. Since efforts were made not to influence the oral hygiene of the participants by any other means, it was suggested that factors other than the mechanical professional cleaning were responsible for the maintenance of gingival health. The patients may have been motivated to improve their oral home care due to their participation in the program. *Department of Periodontology, Royal Dental College, Vennelyst Blvd., DK-8000 Aarhus, Denmark*

Dr. Richard Singer

OCCUSAL ADJUSTMENT FOR A PHYSIOLOGICALLY BALANCED OCCLUSION

McNamara, D. C.

J Prosthet Dent 38: 284, September, 1977.

A total of 18 patients with histories of masticatory system dysfunction, but whose acute disturbances had subsided, were analyzed prior to and following occlusal adjustments. Nine of these patients underwent prosthetic reconstruction with fixed partial dentures. The two groups were compared with a control group whose dentitions were in harmony with the TMJ and the neuromuscular apparatus. The EMG silent period duration and the mechanical latency of the jaw-opening reflex were measured by means of electromyographic recordings of the bilateral temporal and masseter muscles. The repeatability of the median occlusal position was demonstrated by means of phase-plane traces of jaw-closing velocity as a function of position. The mean duration of EMG silent periods and latency of the jaw-opening reflex were dramatically reduced after equilibration procedures according to statistical analysis. This study indicated that occlusal adjustment techniques will remove deflective contacts and prolonged EMG reflex inhibitory pauses of the masticatory elevator muscles at the median occlusal position to within the range of the control group. *One Felton Road, City Beach, Western Australia, 6015, Australia*

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