STUDIES IN PARTIAL DENTAL PROSTHESIS

IV. FINAL RESULTS OF A 4-YEAR LONGITUDINAL INVESTIGATION OF DENTOGINGIVALLY SUPPORTED PARTIAL DENTURES

by

GUNNAR E. CARLSSON

BJÖRN HEDEGÅRD

KALERVO K. KOIVUMAA

INTRODUCTION

In a longitudinal clinical study of 99 patients provided with various types of dentogingivally supported partial dentures we found that after a follow-up period of only one year there was a relatively high frequency of local pathologic alterations (Study I, 1960). On analyzing the group with lower double free-end dentures (residual dentition of Kennedy class I), and full maxillary dentures it was found that the tissue alterations at the abutments were more common and severe than for the series as a whole (Study II, 1961). At a new examination of this series 2 years after the dentures had been provided, the periodontal and caries status had further deteriorated among the patients that had worn their partial dentures (Study III, 1961). There was a strong correlation between the presence of local pathologic alterations accompanying the use of partial dentures and poor oral hygiene. In view of the short follow-up period the results of the treatment must be regarded as being comparatively unsatisfactory. It was concluded therefore that the indications for partial dentures should be narrowed considerably and that the dentures should be designed so that the possibility of their causing damage is minimized. The value of instructing the patients on various prophylactic measures was stressed.

A final examination of the whole original series 4 years after the dentures had been provided was considered to be of interest

in order to determine the further development of the pathologic alterations. This was duly performed and the results are reported in this paper.

MATERIAL

The original series consisted of 99 persons, all of whom had been provided with various types of partial denture at the Royal School of Dentistry, Umeå, between March and June 1959. In June, 1960, that is, 12 to 15 months after the dentures had been handed to the patients, 90 of them (91 per cent) underwent a follow-up check, the results of which have been published as Study I. At the end of March and the beginning of April, 1963, the whole of the original series of patients was recalled for a further clinical and radiologic examination, and 88 of them (89 per cent) attended. Of the 11 absentees, 7 had moved from the district, 2 had been ill for a long time, one was prevented from attending by his work, and one could not be reached by telephone or letter.

After the one-year and in some cases (group IV, see below) after the 2-year follow-ups the patients requiring conservative and periodontal treatment, and adjustment of their dentures were asked to attend the clinic. Thereafter the patients had themselves to apply for any revisory treatment.

In view of the earlier reports only patients examined after one year will be included in the results. (For the group with full upper and lower double free-end saddled dentures another follow-up was carried out after 2 years).

In the compilation and presentation of the results the patients have been classified according to the following treatment groups: The 13 patients that originally had both upper and lower partial dentures have been assigned to the appropriate group for each jaw.

I. Patients with lower partial dentures (48 patients)
II. Patients with upper partial dentures (18 patients)
III. Patients that had not used their partial dentures; neither upper nor lower (15 patients)
IV. Patients with lower partial dentures with double free-end saddles and full upper dentures (part of group I) (28 patients)

V. Patients with change in denture status during the follow-up period (20 patients).

Table 1 shows the composition of the treatment groups I—IV. Group V is described in greater detail under *Results*.

Table 1.

Composition of treatment groups I—IV

Group	No. of cases	No. of abutments	No. of indirect abutments	No. of other teeth
Group I	48	120	131	76
„ II	18	51	37	47
„ III	15	35	69	17
„ IV	28	66	88	12

METHOD

1. Clinical examination

A detailed account of the method of examination and definitions was given in Study I. The same two investigators made the clinical examination in the 4-year follow-up but on this occasion they worked together (*Markén*, 1962) so that any discrepant findings could be discussed and agreement reached on what was to be recorded.

For the statistical analysis the usual formulae for standard deviations, the *t*-test and the *chi*-square test were used (*Bailey*, 1959). As in Study III, the following levels of significance were applied: $P < 0.01$, significant; $0.01 < P < 0.05$, almost significant.

The patients in group V were excluded from the statistical analysis.

2. Radiographic examination

Intraoral radiographs of the abutments were taken at the beginning of the treatment and at the various follow-up examinations. The radiologic technique with the isometric Dieck-Cieszynski angulation was used routinely. Care was taken to avoid over-axial setting. For the patients for whom double free-end saddle dentures were made, a comparison was made of radiographs taken before the denture treatment and 4 years later (28

denture wearers, 9 others). The comparison was made in respect of (1) the level of the marginal bone in relation to the length of the tooth, measured with a Waerhaug ruler (*Schei et al.*, 1959), (2) the condition of the alveolar bone margin, especially its compact border, mesial and distal to the abutment, and (3) the width of the periodontal space in the marginal area. These evaluations and comparisons were performed by two investigators independently. As in the clinical examination when the findings were discrepant the evaluations were discussed until agreement was reached. The radiographs were tabelled in code so that the observers should not know whether they had been taken for denture-wearers or non-denture-wearers. Nor should they be able to link the clinical registration with the respective teeth.

3. Patients' views on their dentures

At an interview each denture-wearer was asked 18 questions so formulated as to sound the patient's opinion on various aspects of the denture treatment and its results.

RESULTS

1. Clinical study

Group V

An account is given first of the results for the 20 patients who, because of change in the denture status during the follow-up period, are not included in the following report of the clinical observations.

1. Three women had had their remaining teeth extracted and the partial dentures had been replaced by full dentures. Two women had had some of their remaining teeth extracted, and new partial dentures had been fitted (telescope type). All these 5 initially had less than 6 remaining teeth and partial lower dentures with wrought clasps; extractions had been performed owing to caries and periodontal disease.

2. One man had received a new lower partial denture after severe decay of the abutments had necessitated crown restorations.

3. One man and one woman had stopped wearing their partial

lower dentures as the cobalt-chromium framework had fractured during the previous year. One man did not use his partial lower denture for 3 months because a badly decayed abutment had been extracted.

4. Two men and one woman had had their partial dentures replaced by fixed bridges (1 upper, 2 lower dentures).

5. One man did not use his partial denture after his jaw had been fractured a year previously.

6. Five men and 1 woman had given up wearing their partial dentures after the first part of the follow-up period (1 upper, 4 lower).

One man had for the last 2 years taken to wearing his lower partial denture, which he had previously felt he could not tolerate.

These patients constitute 23 per cent of the series followed up. The effect that these patients may have on the results for the material as a whole is discussed below.

Groups I—IV

The results for the other patients attending all the follow-ups are presented here in the form of graphs (Figs. 1—7), with frequencies for the various treatment groups. The principal results are analysed below.

A significant number of *abutment teeth* of denture-wearers became loose during the follow-up period; at the 4-year check they comprised 18 per cent of the four groups. A further 25 per cent showed a tendency for increased mobility. For 5 per cent of the abutments both horizontal and axial mobility were recorded. The total of teeth that were loose and that showed a tendency for mobility are given in Fig. 1, and in Fig. 2 the same findings for the abutments. The frequency of the changes was more marked in the case of lower than upper dentures, but the differences are not statistically significant. There was no evidence of a sex difference in respect of the change in mobility of the abutments.

For the patients not wearing their dentures there were no significant changes in the mobility of the teeth.

There was no significant increase in the number of loose *indirect abutments*. Teeth with a tendency for increased mobility

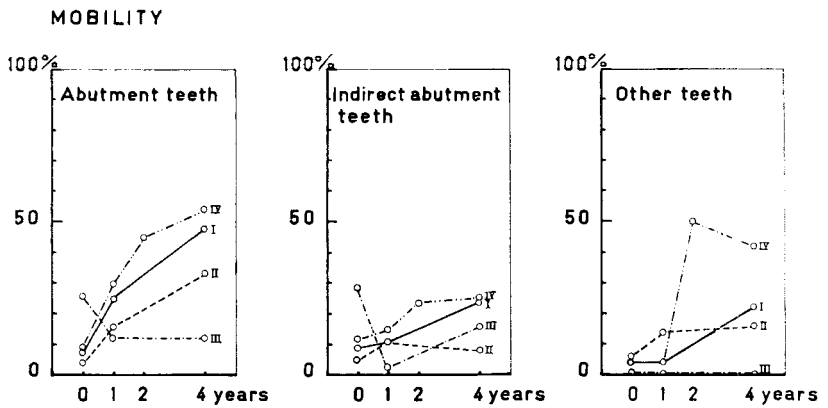


Fig. 1. Frequency of mobile teeth for different patient groups during the 4-year follow-up period (teeth with a tendency for increase in mobility counted as mobile).

throughout the 4-year follow-up period increased from 2 to 13 per cent for the wearers of lower partial dentures. Those not wearing their dentures showed no significant differences in mobility.

As regards the *other teeth* there were no significant changes in mobility. The proportion of such teeth for which a tendency for increased looseness was recorded rose from 1 to 19 per cent.

Gingival status (Fig. 3). — For the wearers of lower dentures

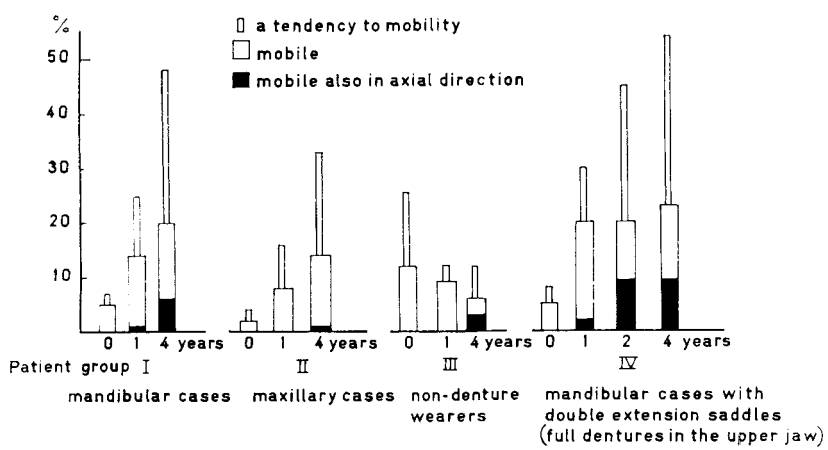


Fig. 2. Frequency of loose abutments for different patient groups with the degree of looseness.

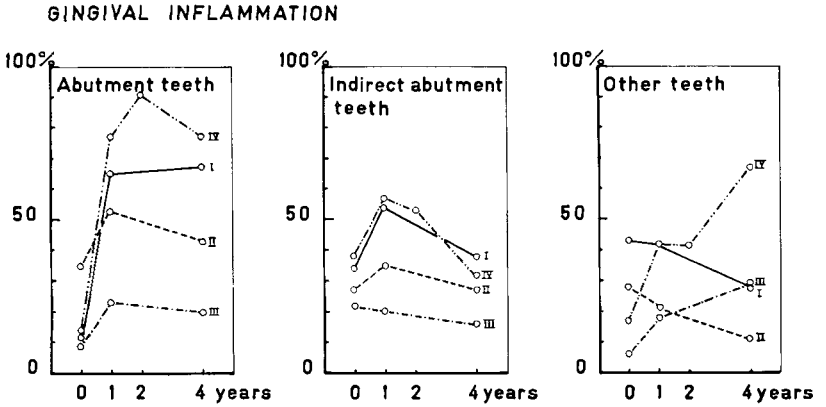


Fig. 3. Frequency of teeth with inflammation of the gingival margin during the 4-year follow-up period.

the percentage of *abutments* with inflammation of the gingiva showed a significant increase from 13 per cent at the time the dentures were made to 65 per cent after one year and 68 per cent at the 4-year check. The frequency of severe inflammation (grade 2) increased from 0 to 13 per cent during the first year, and after 4 years was 17 per cent. For the upper denture wearers no significant differences were noted.

For the control group (who did not wear their partial dentures) no significant changes were found.

The condition of the gingival border around the *indirect abutments* in the mandible deteriorated significantly during the first

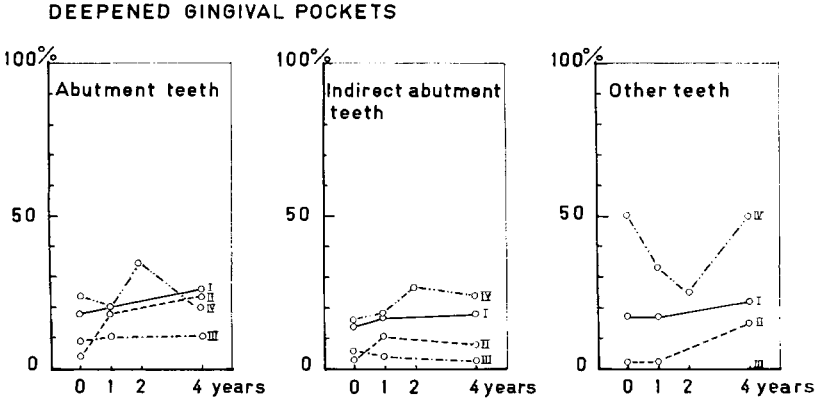


Fig. 4. Frequency of teeth with deepening of the gingival pockets during the 4-year follow-up period.

year, while at the 4-year follow-up there was an almost significant improvement. For the upper denture cases and the control group there were no significant changes.

For the *other teeth* of the denture-wearers, gingival inflammation was significantly less common at the 4-year check (21 per cent) than when the dentures were made (37 per cent).

For the control group there were no significant differences.

Depth of the gingival pocket. (Fig. 4). — For the group of denture wearers the frequency of *abutments* with deepened gingival pockets increased from 14 per cent at the first examination to 25 per cent after 4 years — an almost significant increase. For the other tooth groups and for the patients not using their partial dentures no significant changes were recorded.

Exposure of the cemento-enamel junction. — During the observation period the frequency of teeth with exposed cemento-enamel junctions increased. The development was similar for all the patient groups and the various tooth groups.

Denture-supporting mucosae. (Fig. 5). — After one year 20 per cent of the denture wearers displayed inflammation of the

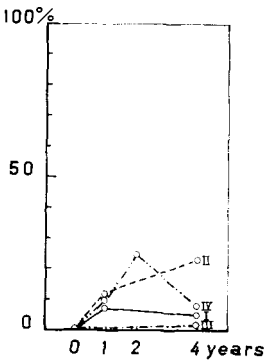


Fig. 5. Frequency of patients with inflammation in the denture supporting mucosa for the different patient groups.

mucosa under one or more saddles. At the 4-year follow-up the frequency was 8 per cent for the lower denture cases and 44 per cent for the upper; thus there was a significant difference between these treatment groups.

Caries in abutments (Fig. 6). — In group IV 41 of the 44 abutments without crowns were attacked by caries during the 4-year

period. For the other denture-wearers 43 of the 74 abutments without artificial crowns were decayed — a significantly lower frequency. Two of the 53 crowned abutments of the denture-wearers were decayed.

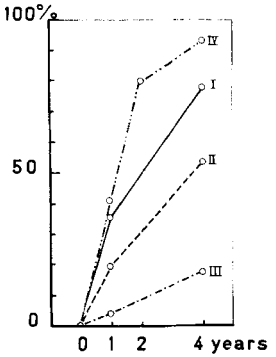


Fig. 6. Cumulative frequency of abutments without crowns which were attacked by caries during the follow-up period for different patient groups.

In the control group 5 of 28 abutment teeth without artificial crowns had decayed during the 4 years.

Condition of the dentures

Occlusion and articulation (Fig. 7). — For all three groups the occlusion of the dentures deteriorated to about the same extent during the first year, at the end of which it was assessed as unacceptable for 21 per cent of all the dentures. In Group IV

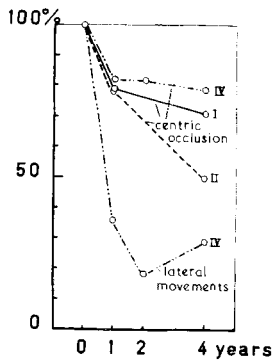


Fig. 7. Frequency of cases with acceptable occlusion and articulation for the different patient groups.

there was no further deterioration, while 45 per cent of the dentures of the patients in groups I and II had defective occlusion at the 4-year follow-up.

The articulation, which was evaluated only for group IV, deteriorated in two-thirds of the cases during the first year, but thereafter showed no significant changes.

Adaptation and retention of the dentures. — So far as the maxillary dentures were concerned, the adaptation of the metal framework and saddles to the supporting tissues had not altered. As regards the lower dentures, however, various defects in this respect came to light during the follow-up period, but no more thorough examination was made because, among other reasons, rebasing had been performed in some of the cases. A loss of active retention in about 30 per cent of the cases was recorded for both upper and lower dentures.

2. Radiographic examination

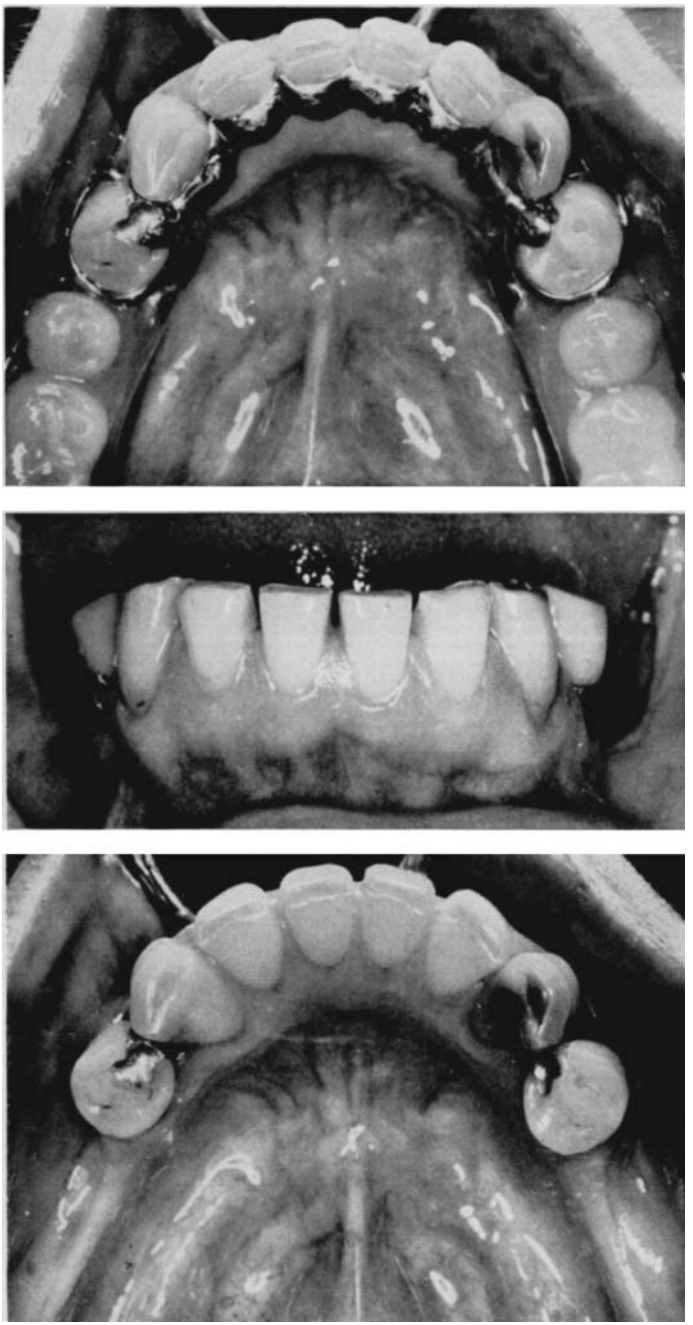
The percentage change in level of the alveolar bone margin during the follow-up period is shown in Table 2. A statistical comparison of the means for denture wearers and non-denture-wearers showed a significantly greater reduction in the marginal bone for the former group, on both mesial and distal aspects.

The greatest lowering among the denture wearers was on the distal aspect. The dispersion of the measurements was also significantly greater for this than for the other sites of measurement (according to the F test of variances).

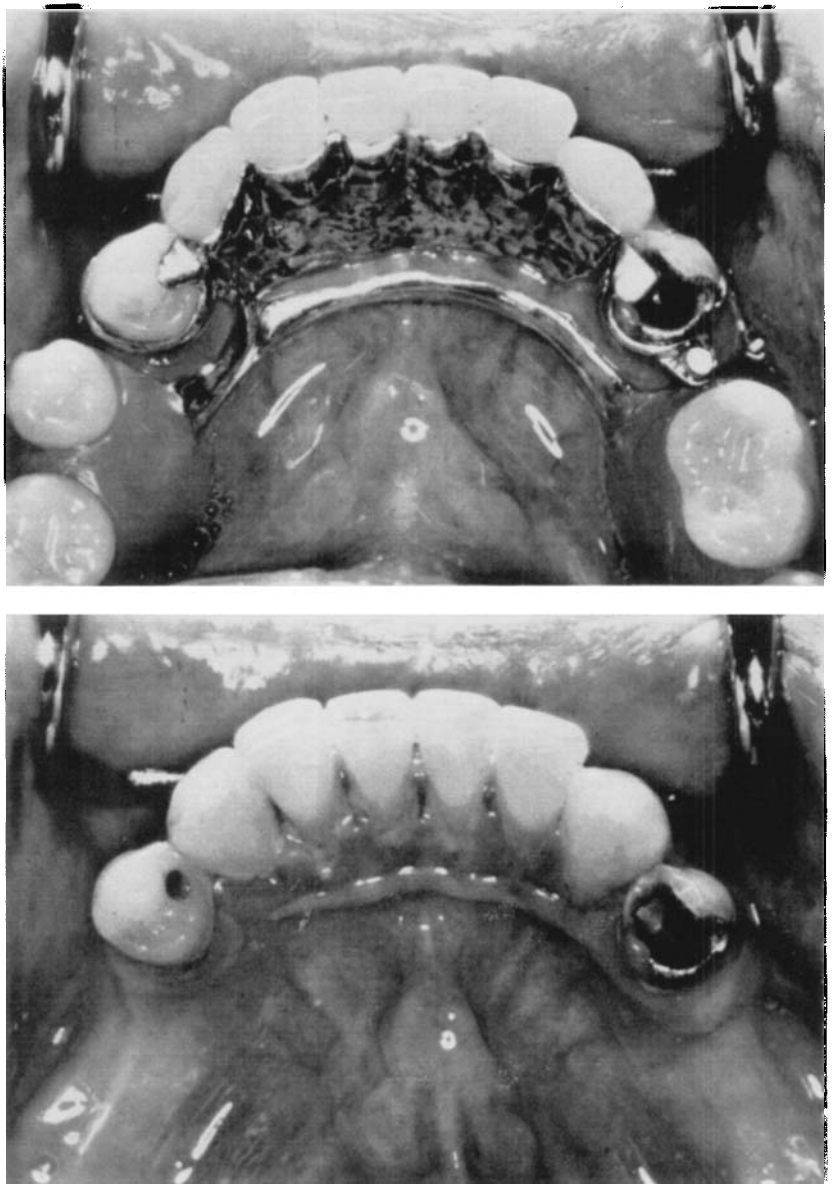
Table 2.

Changes in the level of the alveolar bone during the follow-up period (4 years). Means and standard deviations as percentages of the lengths of the teeth

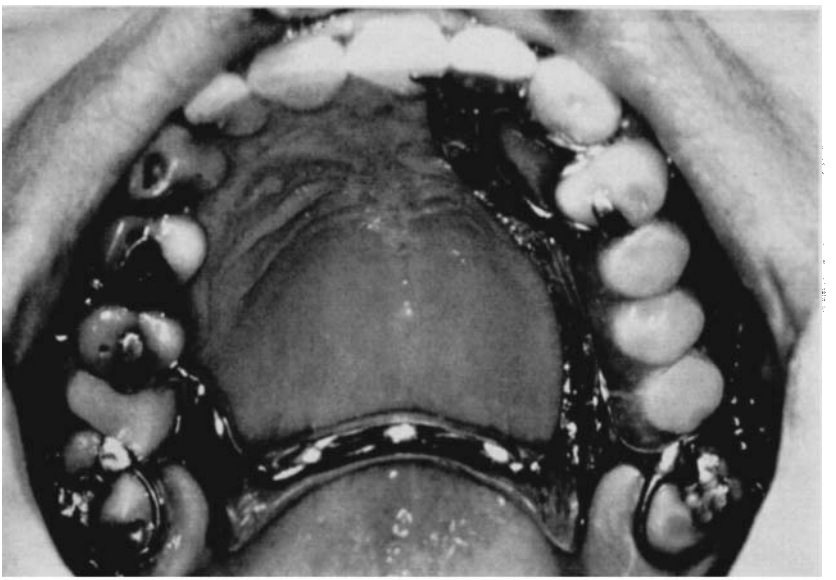
	No. of abutments	Mesial aspect		Distal aspect	
		Mean	S.D.	Mean	S.D.
Denture wearers	56	—2.3	3.3	3.9	5.1
Non-denture-wearers	18	—0.1	2.7	0.2	2.8

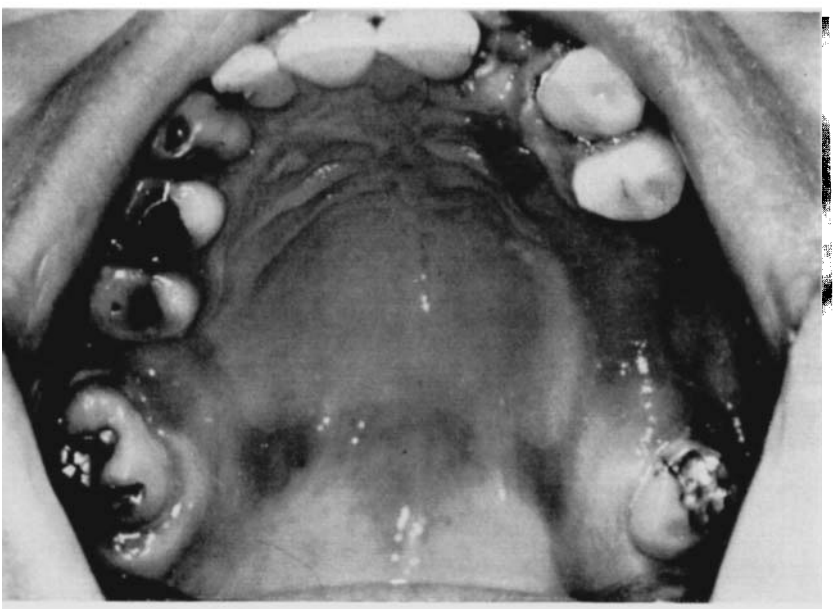


Figs. 8, 9 and 10. Denture case classification Kennedy I. Soft and hard tissues in excellent condition after four years of wearing the partial denture (top picture). Compare these photographs with those of the same case which are reproduced in Study I (Figs. 8 and 9) and in Study III (Figs. 16 and 17).

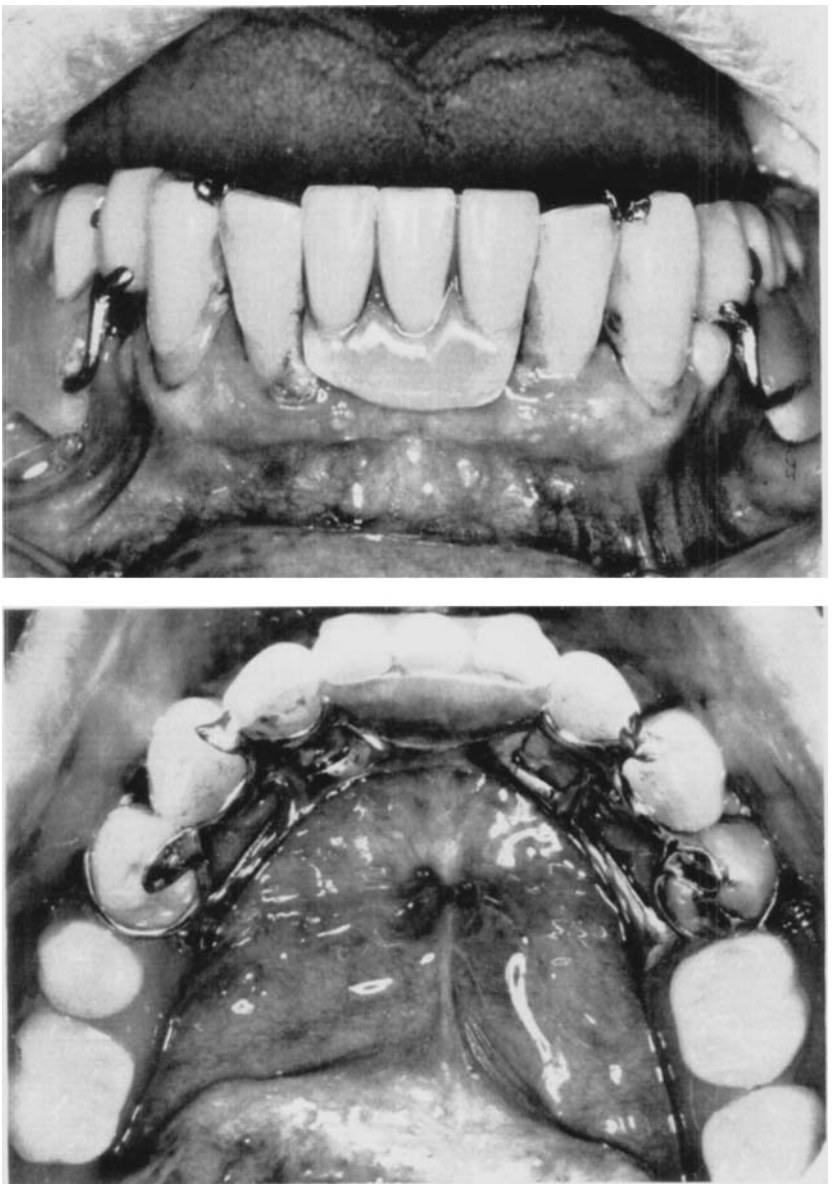


Figs. 11 and 12. Kennedy I. Cast cobalt-chromium skeleton with stress-breaking action through a flexible bar. The lingual plate covers the necks af the teeth and the papillae. Under the plate the gingiva is severely inflamed with necrotic margins and debris accumulation. The marked impression of the plate into the tissue is partly due to the gingiva being swollen. Compare the photographs above with those of the same case in Study I (Figs. 10 and 11).

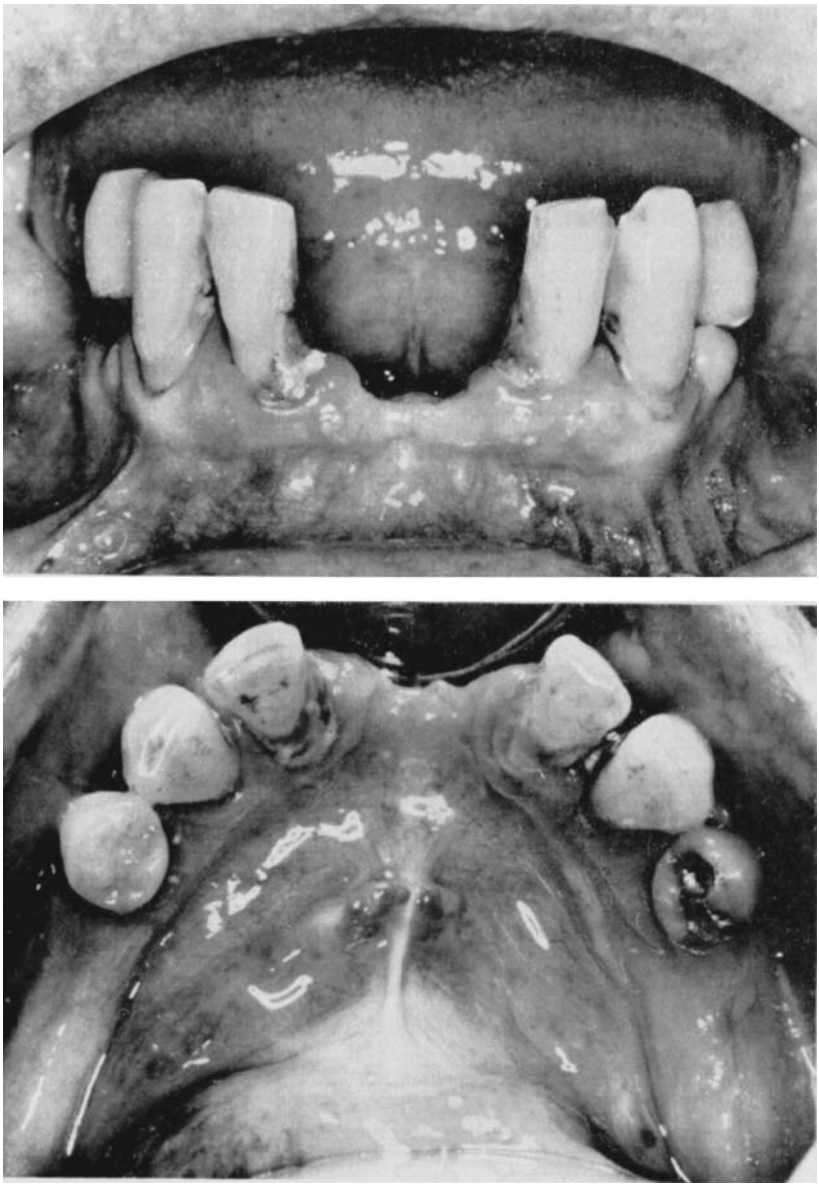




Figs. 13 and 14. Kennedy III[2]. Under the cobalt-chromium denture area appears an inflammatory mucosa reaction, which is more severe in the alveolar ridge regions. There is no evidence of traumatic origin. This mucosal inflammation seems to be of the same intensity as three years earlier. Compare the photographs with those of this case, which are reproduced in Study I (Figs. 14 and 15).



Figs. 14, 15, 16 and 17. Kennedy I[1]. Cast cobalt-chromium skeleton for mandibular denture. Denture worn four years without the patient appearing for adjustment during the last three years. Due to ridge resorption the front part of the denture is raised from its bed. Heavy impressions of bar and connectors into the gingiva. Several caries lesions, calculus formation and gingival swellings and inflammation at the teeth.



Figs. 16 and 17.

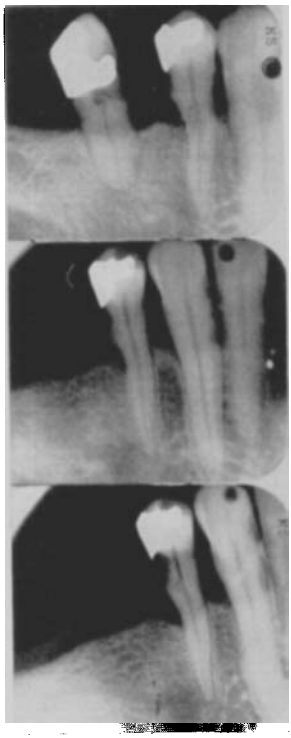


Fig. 18. Same case as in Figs. 14—17. X-ray pictures of the right lower cuspid and first bicuspid at the time of denture insertion (top), one year later (middle) and four years later (buttom). The second bicuspid in the top picture was extracted before denture treatment. It is obvious that the periodontal bone breakdown around the first bicuspid has appeared during the observation time. At the clinical registration at the four year control the first bicuspid accordingly was found to be mobile. Carious lesions are seen to extend around the tooth.

Table 3.

Comparison of radiographic appearances — before and 4 years after the denture treatment — of the marginal bone (mesial and distal aspects) and width of the periodontal space marginally at the most posterior of the remaining teeth

	No. of teeth	Mesial aspect		Distal aspect		Periodontal space	
		Same	Worse	Same	Worse	Same	Wider
Denture wearers	56	45	11	44	12	43	13
Non-denture-wearers	18	18	0	18	0	17	1

From the radiographic evaluation (Table 3) it is seen that hardly any change could be observed for patients not wearing their dentures, while about one-quarter of the abutments of the denture-wearers displayed well defined signs of deterioration including resorption of the compact substance, vertical marginal bone breakdown and widening of the cervical periodontal space. For all the teeth that were loose also in the axial direction (grade 2) there were radiographic alterations. On the other hand, there was not a close correlation between radiographic findings and clinical evaluation for the other degrees of mobility.

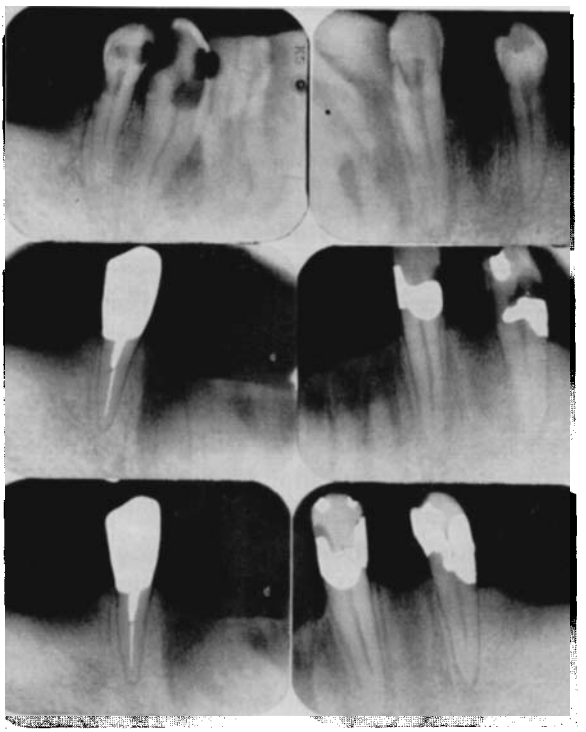


Fig. 19. X-ray pictures of remaining teeth in a lower denture case classified as Kennedy I[2]. The right lower first bicuspid and the left lower cuspid and second bicuspid are used as abutments and all other lower teeth (top picture) were extracted before denture treatment. A comparison of the marginal bone condition at the one-year and the four years controls shows no bone deterioration. At the clinical evaluation these teeth were not considered mobile. Frequent carious lesions have appeared during the observation period. (Note the fairly translucent area at the region for the right lower cuspid even four years after its extraction).

3. Patients' opinions of their dentures

The replies to the questionnaire may be summarized as follows:

Denture comfortable	88 per cent
Chewing efficiency improved	97
Satisfactory chewing efficiency	94
Satisfactory aesthetic result	90
Food trapping	48
Irritation from lingual bars, clasps, etc.	12
Sore saddle areas	6
Interference with speech	2.

The replies to individual questions in the questionnaire yielded the following results:

Satisfactory masticatory efficiency was recorded for most of the patients, although 42 per cent stated that tough food gave them trouble. Only one patient stated that the denture interfered with speech. Seven others stated that certain sounds (*s*, *d* and *t*) were difficult to pronounce but considered that there was no real impediment to speech.

Thirty-two per cent of the patients observed changes in their dentures (decrease in retention and "sinking in") but most found the dentures still comfortable.

The only objection to the aesthetic results of the treatment was in respect of the colour of the artificial teeth (12 per cent).

DISCUSSION

For the validity of a clinical investigation it is fundamental that there should not be excessive wastage from the original case series. Obviously, even when the number of absentees is quite small there may be a selection bias but the risk of seriously impairing the validity of the results increases rapidly with the number of patients lost to the investigation.

In discussions on the effect of selection bias due to absentees in clinical investigations it is often held that patients with real or imagined complaints will be over-represented. In view of the fact, confirmed in these studies (I—IV), that the patients were mostly unaware of the injuries to the oral tissues discovered at the follow-ups, it may be suggested that the patient's attitude to dental care and his knowledge of the need for regular checks may play an important role in selection. The more seriously-minded patients are more likely to attend an examination to which they are re-called than are others. The influence of such factors on the representativeness of the sample attending the examination does not seem to have received due consideration in earlier clinical investigations of partial denture cases.

To throw light on the importance of representativeness in a clinical series the results of two English studies may be quoted. One is a survey on partial dentures of the onlay type (*Saunsbury*, 1961). The author reports very discouraging results for 75 patients fitted with such dentures, re-examined every third month during the first year and then every sixth month for periods of up to 5 years. Fifty-two per cent of the patients were compelled for various reasons (caries and periodontal breakdown at abutments) to discard their appliances during the first 2 years and only 30 per cent were able to tolerate their appliances for 3 years or more.

In the other study, by *Tomlin & Osborne* (1961), patients with partial cobalt chromium dentures of various designs were re-examined after 2—5 years. Of the large original series of 376 patients 38 per cent (143 patients) were followed-up. The clinical results reported by Tomlin & Osborne must be considered very satisfactory compared with those of Saunsbury's study, especially in view of the comparatively long period. These favourable results may not, however, be representative of the series as a whole, owing to the very high wastage (62 per cent) of which few details are given.

Any comparison between these two investigations will naturally be affected by the differences in composition of the series, investigation methods, design of dentures and other factors. The wide difference in results can, however, also be due to the comparatively high loss of follow-up in the Tomlin—Osborne series.

In the present investigation the attendance was practically the same for the 4-year as for the one-year follow-up (89 and 91 per cent, respectively). In view of the long period this is highly satisfactory. For all 11 absentee patients (11 per cent) there was a non-dental reason for their absence. Even if it is suspected nevertheless, that there was some link between the denture treatment and the absence of any of the patients professing illness or work as the reason for not attending, it is inconceivable that this would have biased the results.

The figures and graphs presented under *Results* provide a more favourable picture than would have been the case if the 20 cases reported separately (group V) had been included. In this respect, however, this study provides a brighter picture of the situation after 4 years' use of the partial dentures than would have been expected from the results of the follow-ups of the first 2 years.

Thus, at the 4-year check 37 out of the 66 patients that had worn their partial dentures throughout the period did not display severe clinical or radiologic periodontal destruction at the abutments. To this group were assigned all the cases with the following criteria: none of the abutments were clinically loose (grades 1 or 2), but a tendency to mobility was permissible; the gingiva around the abutments was not severely inflamed (grade 2); no definite radiographic deterioration of the marginal bone. In this group, however, extensive caries lesions were often present in the abutments. As so many patients stopped using their partial dentures during the 4-year period (25 per cent) or new dentures were supplied as replacements (9 per cent), the group with acceptable results of treatment constitutes only 37 per cent of the 101 original partial dentures followed for 4 years.

On the basis of the high correlation between oral hygiene on the one hand and dental and periodontal lesions on the other, observed at the earlier follow-ups and again confirmed after 4 years, it would seem justified to conclude that where a high standard of oral hygiene is observed a partial denture can usually be tolerated by the oral tissues without risk of pathologic alterations.

Where indicated, group IV was called for conservative and periodontal treatment and denture correction after one and 2

years, the others only after the one-year follow-up. For any further revisory treatment the patients themselves had to apply. In some cases this treatment and the recommendations and instructions on oral hygiene technique given in this connection were undoubtedly of importance to the results.

No analysis of the effect of the various types of denture and restorations was attempted largely because of the difficulties of evaluating the 20 cases whose denture status changed during the period. In the present series it is therefore difficult to obtain elucidatory results other than on a few individual points. For one thing the series is comparatively small and heterogeneous, and then any effect of the dentures may be masked by differences between the denture-wearers with respect to various biologic conditions and the efficiency of oral hygiene.

Among the more clear-cut observations, however, was the tendency to less pronounced periodontal changes for the upper than for the lower denture cases. Among the latter, group IV shows the most severe damage. This may be due to the unfavourable stress conditions for double free-end dentures, and to the greater tendency to oral damage for this group. The maxillae were already edentulous.

The clinical observations also showed that as far as possible contact between parts of the denture and the gingival border should be avoided. Inflammation, often severe, was commonly seen in connection with such details as lingual screen and bar, connectors between bar and clasp, clasp retentions, occlusal rests and parts of a saddle bearing unduly on the periodontal tissues. Such damage was particularly severe when the dentures had "set" owing to fracture of occlusal supports and/or non-compensated resorption of the alveolar ridge. These injuries would appear not to be avoidable by good oral hygiene.

None of the denture-wearers' 18 abutments that were provided with crowns, fixed to adjacent crowned teeth displayed clinical or radiographic signs of severe periodontal damage. This observation to some extent supports the view that by splinting it is possible to improve the resistance of the abutments to the destructive action of the partial denture.

The analysis of the radiographic material was restricted to group IV because only here was the accuracy of measurement

sufficiently high. Errors in the visualization of the alveolar border in intraoral radiographs are smaller for the mandible than for the maxilla, chiefly because in the former the film can be placed largely parallel to the teeth while in the maxilla there is usually a relatively great angle between the film and the tooth. The level of the alveolar border has been expressed as a percentage of the length of the tooth and not in relation to the maximum level of the bone, which would seem to be the more common procedure (*Marshall-Day & Shourie*, 1955; *Schei et al.*, 1959; *Thomas et al.*, 1962). The reasons for this choice are (1) that the cemento-enamel junction is often concealed on the radiographs from the 4-year check by cervical amalgam fillings placed during the follow-up period, and (2) that a comparison between the measurement of the level of the alveolar border in relation to the maximum level of the bone and in relation to the length of the tooth respectively disclosed a smaller error for the latter technique.

Even when account is taken of the comparatively large error of the method in an investigation of this type, the measurement results (Table 2) indicate that double free-end dentures in the mandible produce a more rapid sinking of the alveolar bone margin at the abutments than that which occurs when no dentures are worn, and that this difference is most pronounced on the distal aspect though not insignificant mesially. This is probably to be ascribed to (1) the direct pressure on the underlying bone exerted by the partial denture, and (2) to the deleterious effect of the partial denture on the periodontal tissues of the abutments, which was evident from the clinical study. The resulting impairment of oral hygiene is a contributory factor. A comparison between the intraoral radiographs taken routinely before and 4 years after the denture treatment disclosed well defined changes in the periodontal bone in fairly many cases (about every fourth abutment). A properly applied routine X-ray technique can therefore be a valuable supplement to clinical observations in the study of the effect of dentures on the underlying tissues. The radiologic findings after 4 years thus confirm the results of the preliminary X-ray study performed after the one-year follow-up (*Hedegård, Carlsson & Koivumaa*, 1960).

CONCLUSIONS

From the results of the series of studies it would seem that under favourable conditions partial dentures can be used for good bite rehabilitation for relatively long periods without incurring a major risk of damage to the remaining teeth. The "favourable circumstances" include a high standard of oral hygiene, an interest on the part of the patient in maintaining the primary benefits of the treatment. On the dentist's side some simple principles of construction should be observed: in particular the gingival border should be protected as far as possible from direct pressure and through efficient occlusal support the masticatory pressure should be transferred to the abutments, and so as to act in the axial direction - even if the number of residual teeth is very small.

Under unfavourable conditions, however, as a result of for instance poor oral hygiene, poor cooperation and defective design, the wearing of a partial denture can imply an environmental change in the oral cavity that rapidly leads to severe damage to the remaining teeth.

It is therefore obvious that the indications for a partial denture should be greatly restricted owing to the doubtful prognosis for this type of bite reconstruction for many patients.

Those patients with few remaining teeth, for whom, on careful deliberation, partial dentures are judged to be the treatment of choice, must be carefully informed by their dentists of the necessity for observing good oral hygiene practice and having regular checks. If the treatment is to have reasonably good prospects of success partial dentures should be provided only to patients from whom cooperation can be expected.

SUMMARY

With the object of studying the oral and prosthetic conditions in the use of dentogingivally supported partial dentures a longitudinal study of 99 patients was performed. The results of a one-year follow-up were reported elsewhere (Study I), and parts of the case series were presented in connection with the reports of 1- and 2-year follow-ups (Studies II and III). This report presents the results and analyses of a 4-year follow-up of

88 (89 per cent) of the original case series. In addition to the clinical evaluations, a radiologic examination of the abutments was made and each patient was interviewed regarding his or her opinion of the treatment.

The most important results were the following: Altogether 32 of the followed-up patients (36 per cent) did not use their original partial dentures or they had got new ones during the period of the follow-up. For 10 patients (11 per cent of those followed-up) there was such severe caries and periodontal lesions that extractions and new dentures had been or should have been made. In the case of 4 patients (5 per cent) the dentures had suffered irreparable damage (usually fracture) which necessitated replacements. In a further 35 cases, (38 per cent of the denture-wearers) repairs or re-basing of the dentures were required, in order to make them function properly.

Among the patients wearing their dentures for the whole of the follow-up period there was an increase in the percentage of abutments loosening during the follow-up period; the frequency of gingival inflammation remained approximately constant after the sharp increase of the first year. For 37 patients the results of the treatment were assessed as "acceptable", there being no clinical or radiographic evidence of appreciable periodontal damage. This group constitutes only 41 per cent of those that could be followed during the 4-year follow-up period, or 56 per cent of the denture-wearers.

There was a tendency for damage to the oral tissues to be more severe in the case of lower than upper partial dentures; inflammation of the denture-supporting mucosa, however, was significantly more common in the maxillary cases. According to the radiographic study, the level of the alveolar bone margin, both mesially and distally to the abutments, had been reduced more for the denture-wearers than for the patients not wearing dentures.

Comparison between the radiographs of the most posterior of the remaining teeth, taken prior to and 4 years after the denture treatment disclosed hardly any change in the case of patients that had not worn their dentures, whereas about one quarter of the abutments of the denture-wearers had undergone definite de-

terioration. At all teeth displaying axial looseness (grade 2) there were radiographic alterations of the alveolar bone margin.

More than 90 per cent of the denture-wearers were satisfied with the results of the treatment from functional, phonetic and aesthetic standpoints. One trouble mentioned by about one-half of the patients was "food trapping". Irritation at various parts of the metal framework or saddle was complained of by only some 12 per cent of the denture-wearers.

Nearly three-quarters of the abutments that had not been provided with gold crowns had been attacked by caries during the follow-up period. For patients with lower double free-end saddle and full upper dentures (group IV) this figure was 93 per cent.

The close correlation between oral hygiene and the presence of caries and periodontal lesions, established at the earlier follow-ups, was verified. The success of partial denture treatment would therefore seem to depend to a considerable extent on the patient's cooperation and regular and efficient oral hygiene.

The results of the study suggest that the prospects for the success of partial denture treatment are dependent more on biologic factors than on the design of the denture.

In the discussion a comparison is made of the results after various follow-up periods.

Practical conclusions that may be drawn from the clinical observations in the study series are summarized.

RÉSUMÉ

ÉTUDES SUR LA PROTHÈSE PARTIELLE

IV. RÉSULTATS FINAUX D'UNE ÉTUDE LONGITUDINALE EFFECTUÉE SUR LES PROTHÈSES PARTIELLES À APPUI GINGIVO-DENTAIRE ET PORTANT SUR QUATRE ANS

Dans le but d'étudier les conditions buccales et prothétiques lors de l'utilisation de prothèses partielles à appui gingivo-dentaire, une étude longitudinale a été effectuée sur 99 patients. Les résultats d'un contrôle fait au bout d'un an ont été rapportés ailleurs (Etude I) et une partie de la série de cas a été présentée lors des comptes-rendus des examens de contrôle faits au bout

d'un an et au bout de deux ans (Etudes II et III). Le présent compte-rendu présente les résultats et les analyses d'un examen de contrôle fait au bout de 4 ans sur 88 (89 %) des patients de la série de cas du début. En plus des évaluations basées sur l'observation clinique, un examen radiologique des dents d'ancrage a été fait, et tous les patients ont été interrogés sur leur opinion à l'égard du traitement.

Les résultats les plus importants étaient les suivants: En tout 32 des patients suivis (36 %) n'utilisaient pas les prothèses partielles du début, ou avaient reçu de nouvelles prothèses pendant la période d'observation. Pour 10 patients (11 % des patients suivis), il était apparu des caries ou des lésions parodontales d'une telle gravité que des extractions et de nouvelles prothèses avaient été effectuées ou auraient dû l'être. Dans 4 cas (5 %) les prothèses avaient été endommagées de manière irréparable (généralement par fracture) rendant nécessaire leur remplacement. Dans 35 autres cas (38 % des porteurs de prothèses), une réparation ou un rebassage des prothèses étaient nécessaires pour qu'elles puissent fonctionner de façon satisfaisante.

Parmi les patients ayant porté leur prothèse pendant toute la période de contrôle, il s'est produit une augmentation de la proportion de dents d'ancrage mobiles pendant la période de contrôle; la fréquence des inflammations gingivales demeurait à peu près constante après l'augmentation accentuée de la première année. Pour 37 patients les résultats du traitement étaient considérés comme "acceptables", vu l'absence de signes cliniques ou radiographiques de lésions parodontales appréciables. Ce groupe ne constitue que 41 % des sujets suivis pendant la période de quatre ans, ou 56 % des porteurs de prothèses.

Il existait une tendance à ce que l'effet sur les tissus buccaux fût plus sévère dans les cas de prothèses inférieures que dans les cas de prothèses supérieures; l'inflammation de la muqueuse d'appui était cependant significativement plus fréquente dans les cas de prothèses supérieures. D'après l'étude radiographique, le niveau du rebord osseux alvéolaire, tant du côté mésial que du côté distal des dents d'ancrage, avait plus fréquemment subi un retrait chez les porteurs de prothèses que chez les sujets ne portant pas leurs prothèses.

La comparaison des radiographies des plus postérieures des

dents restantes prises avant le traitement prothétique et au bout de 4 ans ne mettait guère en évidence de différence dans le cas des patients n'ayant pas porté leurs prothèses, tandis qu'environ un quart des dents d'ancrage étaient nettement endommagées chez les porteurs de prothèses. Pour toutes les dents mobiles dans le sens axial (2ème degré), il y avait des signes radiographiques d'altération du rebord osseux alvéolaire.

Plus de 90 % des porteurs de prothèses étaient satisfaits du résultat du traitement du point de vue fonctionnel, phonétique et esthétique. Un des ennuis cités par environ la moitié des patients était le tassement de débris alimentaires; 12 % des porteurs de prothèses seulement se plaignaient d'irritation au niveau de diverses parties du châssis métallique ou des selles.

Près des trois-quarts des dents d'ancrage qui n'avaient pas été recouvertes d'une couronne d'or avaient été atteintes par la varie pendant la période de contrôle. Pour les patients portant une prothèse inférieure à double selle en extension et une prothèse complète du haut (groupe IV), la proportion était de 93 %.

La proche corrélation que les examens de contrôle précédents avaient mise en évidence entre l'hygiène buccale et la présence de caries et de lésions parodontales a été vérifiée. Le succès du traitement par prothèses partielles semblerait donc dépendre dans une mesure considérable de la coopération du patient et d'une hygiène buccale régulière et efficace.

Les résultats de cette étude semblent indiquer que les chances de succès du traitement par prothèses partielles dépendent plus de facteurs biologiques que de la conception de la prothèse.

Dans la discussion, une comparaison est faite entre les résultats obtenus après différentes périodes de contrôle.

Les conclusions pratiques qui peuvent être tirées des observations cliniques faites dans cette série d'études sont résumées.

ZUSAMMENFASSUNG

UNTERSUCHUNG ÜBER PARTIELLE PROTHESEN. IV.

Um die Entwicklung der oralen und prothetischen Verhältnisse bei der Anwendung dentogingival gestützer Teilprothesen beurteilen zu können wurde eine longitudinale Untersuchung bei 99 Patienten durchgeführt. Die Resultate einer Einjahreskontrolle

sind in *Studie I* niedergelegt, Teile des Patientenmaterials sind ausserdem für Einjahres- und Zweijahreskontrollen in *Studien II und III* vorgelegt worden. Dieser Artikel stellt die Resultate und Analysen einer Vierjahreskontrolle vor, zu welcher 88 (89 %) der ursprünglichen Patienten sich einfanden. Ausser den klinischen Beobachtungen ist eine röntgenologische Untersuchung der Stützzähne und eine Befragung von verschiedenen Prothesenverhältnissen vorgenommen worden.

Die wichtigsten Resultate können folgendermassen zusammengefasst werden:

32 (36 %) der nachuntersuchten Patienten trugen nicht mehr die ursprünglich verfertigten Partialprothesen oder hatten während der Beobachtungszeit neue Konstruktionen ausführen lassen. Bei 10 Patienten (11 % von den Nachuntersuchten) waren so umfassende Karies- und parodontale Veränderungen eingetroffen, dass Extraktionen und neue Prothesenkonstruktionen ausgeführt werden mussten oder schon ausgeführt waren. Bei 4 Patienten (5 %) waren irreparable Prothesenveränderungen (am meisten Brüche) geschehen, was neue Konstruktionen notwendig machte. Noch 25 Patienten (38 % von den Prothesenträgern) bedurften Reparaturen und/oder Unterfütterungen um wieder ganz funktionsfähige Teilprothesen zu bekommen.

Bei den Patienten, die während der ganzen Beobachtungszeit die partiellen Prothesen angewandt hatten, ist eine fortgesetzte Zunahme der Frequenz von beweglichen Stützzähnen geschehen, während die Frequenz marginaler Zahnfleischentzündungen nach dem kräftigen Zuwachs des ersten Jahres ungefähr konstant gewesen ist. Bei 37 Patienten wurde das Behandlungsresultat als akzeptabel beurteilt: ohne klinische oder röntgenologische Zeichen schwererer parodontaler Schädigungen. Da so viele der ursprünglich verfertigten Teilprothesen nicht mehr getragen wurden, besteht diese Gruppe nur von 37 % von denen, die während der 4-jährigen Beobachtungszeit gefolgt werden konnten.

Es gibt eine Tendenz zu mehr ausgesprochenen Schäden bei Anwendung von Teilprothesen im Unterkiefer als im Oberkiefer, ausser der Frequenz von Entzündungen in der prothesentragenden Schleimhaut, die signifikant höher bei Oberkieferfällen ist. Nach der röntgenologischen Studie ist das Niveau des marginalen Knochens, sowohl distal als auch mesial von den Stützzähnen, signi-

fikant mehr bei Prothesenträgern als bei denen, die die Teilprothesen nicht getragen haben, gesunken.

Bei Vergleichungen von Röntgenaufnahmen der letzten Restzähne vor und 4 Jahre nach der Prothesenbehandlung konnte kaum eine Veränderung beobachtet werden bei denen, die ihre Teilprothesen nicht angewandt hatten, während ungefähr jeder vierte Stützzahn bei den Prothesenträgern deutliche Verschlechterungen vorzeigte: Auflösung der marginalen Kompaktabegrenzung mit eröffneten Markräumen, parodontale Destruktionen von vertikalem Typus, Erweiterungen des Periodontalraums im marginalen Anteil. Bei sämtlichen Zähnen mit axialer Beweglichkeit wurden röntgenologische Veränderungen beobachtet.

Die Prothesenträger sind meistenteils (> 90 %) mit dem Behandlungsresultat aus funktionellen, fonetischen und ästhetischen Gründen sehr zufrieden. Eine Ungelegenheit, auf welche doch etwa die Hälfte der Patienten wies, ist dass Speisereste unter Teilen der partiellen Prothesen leicht haften blieben, während Irritationen von verschiedenen Teilen des Gerüstes oder der Sattelgebieten nur von jedem achten Prothesenträger angedeutet wurden.

71 % von den Stützzähnen, die mit Goldkronen nicht versorgt waren, sind während der Beobachtungszeit von Karies angegriffen worden. In einer Gruppe, Patienten mit totalen Oberkieferprothesen und doppelseitigen Unterkieferfreiendprothesen, ist diese Frequenzzahl 93 %. Der frühere festgestellte Zusammenhang zwischen Mundhygiene und Auftreten von Karies und parodontalen Schädigungen ist aufs neue bestätigt worden. Es scheint, als ob die Prognose der Behandlung mit partiellen Prothesen im wesentlichen Grad von Kooperation und Mundhygiene des Patienten abhängig ist.

Die Untersuchungsresultate deuten darauf hin, dass biologische Faktoren grössere Rolle für die Prognose der Partialprothesen spielen, als konstruktionstechnische.

In der Diskussion wird der Effekt verschiedener Frequenzen von nachuntersuchten Patienten auf die Resultate klinischer Untersuchungen analysiert. Praktische Schlusssätze von den klinischen Beobachtungen der Untersuchungsserie werden auch erörtert.

REFERENCES

Studies in partial dental prosthesis

Study I *Koivumaa, K. K., B. Hedegård & G. E. Carlsson*, 1960: An investigation of dentogingivally supported partial dentures. Suom. Hammaslääk. Toim. *56:* 248.

Study II *Carlsson, G. E., B. Hedegård & K. K. Koivumaa*, 1961: An investigation of mandibular partial dentures with double extension saddles. Acta odont. scand. *19:* 215.

Study III *Carlsson, G. E., B. Hedegård & K. K. Koivumaa*, 1962: A longitudinal study of mandibular partial dentures with double extension saddles. Acta odont. scand. *20:* 95.

Other references

Hedegård, B., G. E. Carlsson & K. K. Koivumaa, 1960: Röntgentutkimus dento-gingivaalisesti tuettujen Osaproteesien. Suom. Hammaslääk. Toim. *56:* 320.

Markén, K.-E., 1962: Studies of deviations between observers in clinico-odontological recording. Trans. Royal Schools Dent., Stockholm and Umea, No. 8.

Marshall-Day, C. D. & K.-L. Shourie, 1949: Roentgenographic survey of periodontal disease in India. J. Amer. dent. Ass. *39:* 572.

Saunsbury, Ph., 1961: Clinical experience with onlay appliances. Dent. Practit. dent. Rec. *11:* 196.

Schei, O., J. Waerhaug, A. Lövdal & A. Arnö, 1959: Alveolar bone loss as related to oral hygiene and age. J. Periodont. *30:* 7.

Thomas, A. E., M. C. Busby, Jr., W. M. Ringsdorf, Jr., & E. Cheraskin, 1962: Ascorbic acid and alveolar bone loss. Oral Surg. *15:* 555.

Tomlin, H. R. & J. Osborne, 1961: Cobalt-chromium partial dentures. A clinical survey. Brit. dent. J. *110:* 307.

Addresses:

Gunnar E. Carlsson
Odontological Faculty
University of Umeå
Sweden

Björn Hedegård
Odontological Faculty
Karolinska Institutet
Stockholm Sweden

K. K. Koivumaa
Institute of Dentistry
University of Turku
Finland