Acta odont scand 1971 *29:* 621—638

Keywords:
Denture, partial, removable
Crowns
Periodontium
Tooth supporting structures

From:
The Department of Prosthetics, University of Umeå. the Department of Periodontology, University of Gothenburg and the Prosthetic Clinic, Public Dental Health Center, Luleå, Sweden

PERIODONTAL AND PROSTHETIC CONDITIONS IN PATIENTS TREATED WITH REMOVABLE PARTIAL DENTURES AND ARTIFICIAL CROWNS
A LONGITUDINAL TWO-YEAR STUDY

Bo Bergman
Anders Hugoson
Carl-Olof Olsson

In the present longitudinal study the periodontal and prosthetic conditions in 30 patients treated with removable partial dentures and artificial crowns were followed over a period of 2 years. The patients were given individual instructions in oral and denture hygiene and adequate periodontal treatment before the prosthetic therapy was started. The removable partial dentures were carefully planned and designed. The patients were regularly checked, and necessary instructions, scaling and prosthetic corrections were undertaken. The patients cooperated excellently and no significant deterioration was found in the clinical periodontal status of the remaining teeth. Only a few carious lesions were registered. The present study does not support the opinion that a removable partial denture *per se* will cause periodontal and carious lesions. When teeth with artificial crowns were examined regarding the position of the crown margins it was found that clinically observable gingival inflammations tended to be greatest when the crown margins were subgingivally located. Some deterioration of the removable partial denture occurred during the two-year follow-up concerning preferably occlusion, articulation, stability and clasp retention.

The injurious effect of removable partial dentures has been the subject of several clinical investigations. More or less extensive pathologic changes in the residual teeth and their periodontium have been found in cross sectional investigations (*Andersson & Lammie*, 1952; *Hansson*, 1955; *Andersson & Bates*, 1959; *Tomlin & Osborne*, 1961; *Seeman*, 1963; *Hupfauf & Hupfauf*, 1964; *Löfberg*, 1966; *Derry & Bertram*, 1970) and in longitudinal studies (*Koivumaa*, 1956; *Koivumaa, Hedegård & Carlsson*, 1960; *Carlsson, Hedegård & Koivumaa*, 1961, 1962, 1965; *Carlsson, Ragnarsson & Åstrand*, 1967, 1969).

In view of the poor results of treatment reported, the therapeutic value of a removable partial denture has often been questioned. The present longitudinal

Received for publication, July 13, 1971.

study was undertaken to evaluate the periodontal and prosthetic conditions in patients who had been fitted with a removable partial denture after having received careful periodontal treatment including motivation, instruction in oral hygiene, scaling and surgical elimination of deepened periodontal pockets. The influence of the position of the margin of artificial crowns on the conditions of the gingiva was also studied. This paper reports the result of a 2-year follow-up.

MATERIAL AND METHODS

The material consisted of all patients who between November 1, 1968 and February 1, 1969 received periodontal treatment and who were subsequently supplied with a removable partial denture at the Department of Prosthetics, Umeå University. The patients consisted of 13 men and 17 women with a mean age of 52 years. The age- and sex distribution is given in Table I.

All patients received the following treatment:

1. motivation regarding oral hygiene (individual information and a series of illustrations)
2. instruction in oral hygiene (soft, dense, tooth brush, used with the roll technique, tooth pick, interspace brush, twice a day)
3. scaling
4. surgical elimination of periodontal pockets exceeding 3 mm
5. caries and endodontic therapy when indicated including restoration with artificial crowns of teeth with extensive primary or secondary caries
6. treatment with removable partial dentures.

The artificial crowns were cast gold restorations, in indicated cases provided with porcelain facings. The types of finishing lines used were chisel edge, chamfer or bevelled shoulder. Attempts were made to place the crown margin supragingivally, but for carious and esthetic reasons the margins often had to be placed at the level of, or below, the gingival border.

Table I.
Distribution of primary series of patients by age and sex

Number of patients	Age group —39	40—49	50—59	60—	Total
Males	1	8	4	4	17
Females	3	5	2	3	13
Total	4	13	6	7	30

Table II.

Classification of edentulous areas according to Applegate-Kennedy system for the thirty patients. Three of the patients were supplied with both maxillary and mandibular removable partial dentures

Jaw	Class I —	Class I 1A	Class I 1P	Class II 1A—1P	Class II 1P	Class III 1P	Total
Upper	4	1	—	—	1	1	7
Lower	17	5	3	1	—	—	26
Total	21	6	3	1	1	1	33
Percentage		91		6		3	100

The 30 patients received all together 33 partial dentures. Table II gives the types of residual dentition at the time the patients were provided with a denture. Thus, 30 dentures with bilateral distal extension saddles were made, including 25 for the lower jaw and 5 for the upper. Two patients were supplied with a denture with a unilateral distal extension saddle. One patient was supplied with a tooth-borne upper denture. 19 patients were provided with a complete upper denture in combination with a bilateral free-end saddled denture in the lower jaw.

The removable partial dentures were made after careful planning according to conventional methods (*Krogh-Poulsen*, 1962; *Applegate*, 1965) with a cobalt-chromium framework provided with a lingual bar or continuous clasp, occlusal rests, clasps for direct dental retention and saddles in acrylate to permit rebasing. Care was taken to keep the denture material, clasps, bars and teeth as far away from the gingival margin as possible (*Karlsen*, 1967). For free-end saddles attempts were made to extend the denture base as much as possible.

1—2 weeks after the end of treatment the patients were re-examined. This examination was regarded as the »day zero examination». Twelve and 24 months after day zero examination the patients were recalled for examination and given remotivation, reinstruction in oral and denture hygiene and scaling when indicated.

EXAMINATION

Periodontal conditions

The inflammatory state of the gingiva was scored according to the Gingival Index (GI) system (*Löe & Silness*, 1963).

The periodontal pocket depth was measured to the nearest millimetre with a graduated probe. The pocket depth was recorded at a point in the middle of the buccal and of the lingual surface. The mesio-buccal, mesio-lingual, distobuccal and distolingual pocket depth was measured as close to the contact point as possible. The probe was inserted parallel to the long axis of the tooth. The mean pocket depth represented the pocket depth of the tooth, groups of teeth, individual or group of individuals.

The mobility of the teeth was recorded according to the following criteria:

0 = No mobility
1 = Movable up to 1.0 mm in horizontal plane
2 = » more than 1.0 » » »
3 = » in apical direction

Oral hygiene

The state of the oral hygiene was scored according to the Plaque Index (Pl I) system (*Silness & Löe*, 1964).

All the examinations of periodontal conditions and oral hygiene were made by one of the authors.

Caries

Primary or secondary caries was registrated by probing and examination of radiographs.

Prosthetic factors

Removable partial denture

All prosthetic parameters were assessed according to the criteria described by *Bergman, Carlsson & Hedegård* (1964) and *Löfberg* (1966).

Occlusion was recorded as satisfactory if intercuspidation was correct without observable gliding on repeated habitual closing of the mouth from a postural rest position, and if firm intermaxillary contact could be demonstrated bilaterally and frontally with the aid of a stiff metal spatula.

Articulation was regarded as satisfactory if the denture was stable and free gliding movements (2—3 mm) without cuspal interference were obtained when examined with a stiff spatula. The patients were instructed to perform the movements several times. Articulation in the front region was not examined.

To assess the degree of *direct retention* the denture was removed in the direction opposite to that of insertion. If the clasps offered resistance, retention was considered good.

The denture was regarded as *stable* if it could not be rocked to any appreciable extent by gentle digital pressure against the first molar on the two saddles of the denture.

The *resilence of the alveolar process* was judged only in the front region of edentulous areas. It was evaluated according to a threegrade scale:

Grade 1 Firm mucosa over bone
Grade 2 top of ridge displaceable against the bone
Grade 3 half the height of the ridge or more displaceable against the bone as well as cases without alveolar process.

The appearance of the *mucosa* beneth the denture was judged according to the following scale:

0 = no reddening or changes
1 = local reddening, hyperaemia and decubitus
2 = oedematous, reddened mucosa and/or granulomatous surface of entire supportive area.

Patient's opinion of *comfort and function* of denture was recorded. The patient was asked whether he found construction comfortable and whether he could chew well with it (function). According to the patient's answers, the result of treatment was classified as positive or negative. The patients were also asked if they wore the dentures only in the daytime or also at night.

Crown prosthesis

Notes were made of the position of the margin of artificial crowns relative to the gingival border. The mesial, buccal, distal and lingual edges were recorded according to the following scale:

0 = supragingival
1 = at level of gingival border
2 = subgingival

All prosthetic recordings, both at the initial examination and at the re-examinations one and two years later, were made independently by two of the authors (*Markén*, 1962).

Roentgen examination

Intra-oral radiographs of the abutment teeth were taken with the isometric technique. In addition, bite-wings were taken of all teeth. At the first examination and after two years the following factors were studied:

1) caries
2) periapical lesions
3) level of marginal bone relative to length of abutment teeth.

The level of the marginal bone was expressed as a percentage of the length of the tooth. The method described by *Björn, Halling & Thyberg* (1969) was used and the measurements were performed by one of the authors.

Controls

Ten other patients were examined at roughly the same time as those supplied with removable partial dentures. These 10 patients, 6 women and 4 men, with a mean age of 50 years, served as controls. The number of residual teeth in these patients was, on the average, 19 per patient or 9.5 per jaw. The patients received the same kind of treatment as those in the experimental group, but were not given partial dentures. The controls were examined regarding Gingival Index, pocket depth, tooth mobility and Plaque Index.

Statistical methods

In the statistical analysis comparisons were made with the patient as unit.

The mean values ($\bar{x}$) and standard error of the mean (S.E.) of the parameters studied at the different examinations are given in tabular form. 99 % confidential interval for differences between the theoretical means at 0, 1 and 2 years were calculated from Student's t-distribution for examination for systematic deviations.

To determine the precision of some of the recording procedure duplicate measurements of the Gingival Index, pocket depth and marginal bone level were performed on 6 patients, not belonging to experimental or control material. The precision was calculated as the standard deviation for a single determination from the formula $Se = \sqrt{d^2/2n}$ where d is the difference between duplicate measurements of the same subject.

RESULTS

All 30 patients took part in the 1- and 2-year review. One (a 42-year old man) had, however, not used his partial denture regularly, and the findings of that patient were therefore not included in the account of the results. Of the remaining 29 patients, 21 reported that they used their dentures also at night, and 8 that they used them only in the daytime. The information on this point was the same at both the 1- and 2-year controls. No systematic

Table III.

Gingival Index, pocket depth, tooth mobility and Plaque Index for all the 197 teeth of the 29 re-examined patients supplied with removable partial dentures

Variable	0 year $\bar{x}$	S.E.	1 year $\bar{x}$	S.E.	2 years $\bar{x}$	S.E.
Gingival Index	0.53	0.06	0.48	0.07	0.42	0.05
Pocket depth	1.77	0.06	1.78	0.05	1.82	0.06
Tooth mobility	0.33**	0.08	0.20	0.06	0.08**	0.04
Plaque Index	0.27	0.03	0.34	0.04	0.29	0.05

**Difference 0—2 years significant ($0.001<p<0.01$)

difference between those who wore the denture also at night and those who used the denture only in the daytime was demonstrated regarding the parameters studied. For this reason the results have been described as a whole whether the patients wore their dentures also at night or not.

Determination of the mean error of the variables on Gingival Index, pocket depth and marginal bone level showed no systematic error. Standard deviation of a single observation of the Gingival Index was 0.18, for pocket depth 0.06, and for the marginal bone level 2.02 per cent.

Gingival Index, pocket depth, tooth mobility and Plaque Index. The results are summarized for the 29 patients treated with removable partial denture in Table III and for the 10 control patients in Table IV. With but one exception no changes in the means of the 4 parameters could be demonstrated in any group of patients at the one or two-year review. A decrease ($0.001<p<0.01$) of tooth mobility was recorded between 0 (0.33) and 2 years (0.08) in the removable partial denture group (Table III).

Table IV.

Gingival Index, pocket depth, tooth mobility and Plaque Index for 10 control patients (190 teeth)

Variable	0 year $\bar{x}$	S.E.	1 year $\bar{x}$	S.E.	2 years $\bar{x}$	S.E.
Gingival Index	0.42	0.07	0.55	0.07	0.54	0.10
Pocket depth	2.25	0.06	2.25	0.10	2.05	0.10
Tooth mobility	0.57	0.22	0.42	0.15	0.31	0.25
Plaque Index	0.39	0.08	0.39	0.04	0.31	0.07

Table V.

Gingival Index, pocket depth, mobility and Plaque Index among 63 abutment teeth

Variable	0 year $\bar{x}$	S.E.	1 year $\bar{x}$	S.E.	2 years $\bar{x}$	S.E.
Gingival Index	0.60	0.08	0.58	0.08	0.53	0.07
Pocket depth	1.94	0.08	1.87	0.06	1.93	0.08
Mobility	0.35**	0.09	0.18	0.07	0.07**	0.04
Plaque Index	0.29	0.04	0.37	0.06	0.38	0.08

**Difference 0—2 years significant ($0.001<p<0.01$)

Those teeth responsible for the direct retention are hereinafter referred to as *abutment teeth*. Thirty-six of the sixty-three abutments were provided with artificial crowns.

The result for abutment teeth alone are given in Table V.

The findings for the abutment teeth were largely the same for all variables at the various review times. No differences could be demonstrated for Gingival Index, pocket depth and Plaque Index. A decrease ($0.001<p<0.01$) of tooth mobility of abutment teeth was noted between 0 and two years.

In Tables VI and VII the material is divided into teeth with and without contact with the denture. Neither *within* the group of teeth in contact with or *within* the group without contact with the partial dentures any significant changes could be demonstrated during the 2-year period for Gingival Index, pocket depth or Plaque Index (Table VI). Comparison *between* the two groups of teeth in patients with both kinds of teeth (Table VII) showed no differences at 0, 1 or 2 years.

Tables VIII and IX compare teeth with and without artificial crowns.

Table VI.

Gingival Index, pocket depth and Plaque Index for teeth with and without contact with the removable partial denture

Variable	Teeth *in* contact with the denture (n = 158), 30 patients						Teeth *without* contact with the denture (n = 39), 10 patients					
	0 year		1 year		2 years		0 year		1 year		2 years	
	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.
Gingival Index	0.55	0.07	0.50	0.07	0.44	0.05	0.50	0.10	0.31	0.08	0.35	0.10
Pocket depth	1.81	0.06	1.82	0.06	1.85	0.06	1.61	0.11	1.76	0.10	1.70	0.10
Plaque Index	0.27	0.03	0.36	0.04	0.31	0.05	0.28	0.10	0.22	0.07	0.23	0.08

Table VII.

Gingival Index, pocket depth and Plaque Index for teeth with and without contact with the removable partial denture. Comparisons within patients (n = 10) with teeth of both kinds

Variable	Teeth *in* contact with the denture (53 teeth)						Teeth *without* contact with the denture (39 teeth)					
	0 year		1 year		2 years		0 year		1 year		2 years	
	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.
Gingival Index	0.60	0.13	0.44	0.12	0.41	0.07	0.50	0.10	0.31	0.08	0.35	0.10
Pocket depth	1.78	0.11	1.79	0.10	1.87	0.12	1.61	0.11	1.76	0.10	1.70	0.10
Plaque Index	0.25	0.07	0.27	0.07	0.29	0.08	0.28	0.10	0.22	0.07	0.23	0.08

Within both of these groups the mobility of the teeth was less at 2 years than at 0 year ($0.001<p<0.01$) (Table VIII). Table IX compares teeth with and without artificial crowns in those patients with teeth of both kinds. At the 1-year examination the Gingival Index was lower ($0.001<p<0.01$) in the group without teeth with artificial crowns. At the 2-year control no such difference was demonstrable. Otherwise the comparison revealed no differences between the two groups.

In Tables X—XIV the 61 teeth with artificial crowns were analysed regarding the position of the crown margin. When all the crowns were analysed (Table X) the 2-year review showed no changes regarding Gingival Index *within* any of the groups, position 0, 1 or 2. Within the group, position 0 (supragingival position), the Plaque Index increased from 0.16 to 0.34 during the 2-year control period ($0.001<p<0.01$) (Table XI).

Table VIII.

Gingival Index, pocket depth, mobility and Plaque Index for teeth with and without artificial crowns

Variable	Teeth *with* artificial crowns (n = 61), 21 patients						Teeth *without* artificial crowns (n = 136), 26 patients					
	0 year		1 year		2 years		0 year		1 year		2 years	
	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	x	S.E.	$\bar{x}$	S.E.
Gingival Index	0.62	0.10	0.65	0.10	0.46	0.09	0.51	0.05	0.40	0.07	0.38	0.06
Pocket depth	1.83	0.09	1.84	0.08	1.86	0.06	1.71	0.06	1.77	0.06	1.76	0.07
Mobility	0.19**	0.08	0.08	0.05	0.00**	—	0.37**	0.09	0.23	0.07	0.10**	0.01
Plaque Index	0.24	0.05	0.33	0.04	0.28	0.07	0.29	0.04	0.34	0.05	0.29	0.06

** Difference 0—2 years significant ($0.001<p<0.01$)

Table IX.

Gingival Index, pocket depth, mobility and Plaque Index for teeth with and without artificial crowns. Comparisons within patients (n = 17) with teeth of both kinds

Variable	Teeth *with* artificial crowns (51 teeth)						Teeth *without* artificial crowns (86 teeth)					
	0 year		1 year		2 years		0 year		1 year		2 years	
	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.
Gingival Index	0.65	0.13	0.67**	0.12	0.47	0.11	0.55	0.08	0.41**	0.10	0.34	0.07
Pocket depth	1.79	0.10	1.87	0.09	1.84	0.07	1.72	0.08	1.79	0.07	1.71	0.08
Mobility	0.18	0.09	0.11	0.07	0.00	—	0.28	0.10	0.12	0.07	0.06	0.05
Plaque Index	0.23	0.05	0.33	0.05	0.29	0.08	0.30	0.06	0.35	0.06	0.21	0.06

**Difference between the two groups significant ($0.001<p<0.01$) at one-year control.

Table X.

Gingival Index of teeth with artificial crowns (n = 61) related to the position of the crown margin (21 patients)

Position of crown margin	0 year		1 year		2 years	
	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.
0 (n = 44)	0.50	0.15	0.37	0.10	0.27	0.07
1 (n = 44)	0.34	0.10	0.61	0.18	0.30	0.09
2 (n = 156)	0.74	0.13	0.77	0.12	0.58	0.05

n = number of surfaces. 0 = supragingival position, 1 = position at the level of the gingival border, 2 = subgingival position of crown margin

Table XI.

Plaque Index of teeth with artificial crowns (n = 61) related to the position of the crown margin (21 patients)

Position of crown margin	0 year		1 year		2 years	
	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.
0 (n = 44)	0.16**	0.08	0.21	0.11	0.34**	0.07
1 (n = 44)	0.05	0.04	0.31	0.11	0.11	0.05
2 (n = 156)	0.27	0.06	0.48	0.09	0.29	0.04

n = number of surfaces, 0 = supragingival position, 1 = position at the level of the gingival border, 2 = subgingival position of crown margin.

**Difference 0—2 years significant ($0.001<p<0.01$)

Table XII.

Gingival Index and Plaque Index of teeth with artificial crowns at 0 year related to the position of the crown margin. Comparisons concern only those 11 patients with values for all three positions

Variable	Position of crown margin					
	0 (n = 34)		1 (n = 36)		2 (n = 62)	
	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.
Gingival Index	0.50	0.15	0.34	0.09	0.78	0.14
Plaque Index	0.16	0.08	0.06	0.05	0.26	0.10

n = number of surfaces. 0 = supragingival position, 1 = position at the level of the gingival border, 2 = subgingival position of crown margin.

A comparison of the Gingival Index between various positions of the crown margins at the initial examination and after 1 and 2 years was limited to 11 patients who had values for all 3 positions (Tables XII—XIV). At 1 year the Gingival Index was higher for position 2 than for position 0 ($0.001<p<0.01$) (Table XIII). This thus means that at the 1-year control the Gingival Index was higher when the crown margin was located subgingivally than when it was located supragingivally. At the 2-year control the mean Gingival Index for the group with position 0 was numerically lower than for the 2 other positions (Table XIV). But the difference between the groups was not statistically significant.

Caries. During the 2-year observation period all together 5 carious lesions were seen in patients who had been supplied with removable partial dentures.

Table XIII.

Gingival Index and Plaque Index of teeth with artificial crowns at 1 year related to the position of the crown margin. Comparisons concern only those 11 patients with values for all three positions

Variable	Position of the crown margin					
	0 (n = 34)		1 (n = 36)		2 (n = 62)	
	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.
Gingival Index	0.37**	0.11	0.61	0.18	0.87**	0.13
Plaque Index	0.21	0.11	0.31	0.11	0.52	0.12

n = number of surfaces. 0 = supragingival position, 1 = position at the level of the gingival border, 2 = subgingival position of crown margin

**Difference between position 0 and 2 significant ($0.001<p<0.01$).

Table XIV.

Gingival Index and Plaque Index of teeth with artificial crowns at 2 years related to the position of the crown margin. Comparisons concern only those 11 patients with values for all three positions

Variable	Position of the crown margin					
	0 (n = 34)		1 (n = 36)		2 (n = 62)	
	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.
Gingival Index	0.23	0.11	0.37	0.12	0.48	0.13
Plaque Index	0.27	0.13	0.12	0.05	0.35	0.12

n = number of surfaces. 0 = supragingival position, 1 = position at the level of the gingival border, 2 = subgingival position of crown margin

There was no case of severe destruction of the tooth structure. In one patient 2 lesions were found at the 1 year review, both on surfaces in contact with the denture. At the 2-year control that patient exhibited one further carious lesion on a tooth surface not in contact with the denture. At the 2-year review two further patients showed each one carious lesion, neither of them on surfaces in contact with the prosthesis.

Clinical factors concerning the removable partial dentures. Impairment of various clinical factors are summarized in Table XV. Comparatively few deteriorations were registrated during the 2-year follow-up. Changes were

Table XV.

The number of patients judged as having impaired occlusion, articulation, retention and stability, increased resilience of the alveolar process, and signs of clinical inflammation beneath the denture base between the initial, 1- and 2 year examination

	Occlusion	Articulation	Stability of the denture			Retention of the denture			Increased resilience of the upper frontal alveolar process	Inflammation of denture covered area		
			Full upper	Partial upper	Partial lower	Full upper	Partial upper	Partial lower		Full upper	Partial upper	Partial lower
0—1 year	2	3	4	0	2	4	0	6[a]	1	2[b]	0	1[b]
1—2 years	4	6	3	0	5	0	0	6[a]	2	2[b]	0	1[b]

[a] Impaired clasp retention

[b] Local inflammations

Table XVI.

Means, $\bar{x}$, standard deviations, S.D., expressed as a percentage of the length of the tooth, and values of t for the difference between the level of the bone margin at the abutment teeth at the initial and the 2 year examinations. Only abutments for dentures with distal extension saddle or saddles have been included

Number of patients	Mesial			Distal		
	$\bar{x}$	S.D.	t	$\bar{x}$	S.D.	t
26[a])	0.62	2.26	1.40	1.01	2.31	2.23*

[a]) Twenty-eight of the 29 re-examined patients were supplied with dentures with distal extension saddles. Two patients had to be omitted because acceptable initial radiographs were not available for these patients

* Difference significant ($0.01 < p < 0.05$)

noted most frequently for occlusion, articulation, stability and clasp retention. In addition a crack was seen in the base of one denture, in one a clasp fracture, in one a fracture of a lingual bar and in one a loss of a tooth in the denture.

Patient's opinion. At the 2-year examination 3 patients complained of impaired retention of lower partial dentures and accompanying reduced chewing efficiency. In these cases the clasp retention was impaired. The remaining 26 patients declared that they were satisfied with the comfort and function of the denture.

Roentgenologic examination. Examination of the intraoral radiographs of the abutment teeth revealed that caries had developed on a distal surface of one abutment during the 2-year follow-up. This caries lesion was also diagnosed clinically. No further approximal caries could be detected.

Comparisons between the initial and the 2-year radiographs revealed no differences in the periapical region of any of the abutments.

Comparison of the level of the marginal bone at the abutments as seen at 0 and 2 years disclosed small reductions (Table XVI).

There was a significant reduction in the bone level distal to the abutments ($p < 0.05$), but this was only, on the average, 1.01 per cent of the length of the teeth. Mesial to the abutments there was no reduction.

DISCUSSION

The present longitudinal clinical study was carried out on all 30 patients who had been supplied with removable partial dentures at the Department of Prosthetics within a 3-month period. There is no reason to suspect that the patients at that very time differed essentially from other patients receiving

corresponding treatment at the department. During the 2-year observation period it was possible to follow up all of these patients, which completely eliminated the risk of the effects of selection bias due to absentees. The results reported may therefore be regarded as representative of those obtained at the department.

In an investigation of this type it is difficult to obtain an adequate control material. In the investigation 10 patients were selected at random from those who had received the same periodontal treatment as those in the experimental group and at the time when the patients in the experimental group were being supplied with removable partial dentures. The experimental patients and the controls were age- and sex-matched. Those patients who were supplied with removable partial dentures were in need of fairly extensive treatment because of loss of several teeth. The controls had to be selected among those patients whose dentition was such that the patient did not require a removable partial denture. This means that the controls generally had more residual teeth than the patients in the experimental group. In the present investigation the mean number of residual teeth in the experimental group was 6.6 per patient or 6 per jaw, compared with 19 and 9.5, respectively, for the controls. With reservation for the effect of this difference between the groups on the periodontal condition, comparison between the groups appears to be possible concerning the main problem, namely whether a removable partial denture *per se* has any undesired clinical effect on the tooth and its periodontium.

One patient, a 42-year old man, reported at both the 1- and 2-year review, that he had not regularly worn his partial denture, a bilateral free-end prosthesis of the lower jaw. The state of the periodontium in that patient did not differ significantly from the average in the other patients.

As for the Gingival Index, depth of periodontal pockets and Plaque Index no significant changes could be demonstrated during the 2-year observation period within the group treated with removable partial dentures or within the control group. A decrease of the mobility of the abutment teeth was noted between 0 and 2 years. This reduction must be evaluated with caution, since the examiner might have changed his scale during the observation period. It is, however, obvious that the mobility of the teeth had not increased during the two years' use of the partial denture.

For the radiographic assessment of marginal bone loss a method described by *Björn et al.* (1969) was used. This method may, according to these authors, be suitable for long-term studies on the course of periodontal disease in clinical cases. Only abutments for dentures with distal extension saddles were analysed. Distal to the abutments there was a reduction in the marginal bone level during the two-year follow-up, averaging 1.01 per cent of the bone.

This result is compatible with that of *Carlsson et al.* (1965, 1967). No reduction was recorded mesially to the abutments. As no deterioration was found in the clinical periodontal condition of the abutment teeth the reduction of the bone level distally was probably due to direct pressure on the underlying bone exerted by the denture. Reductions in the height of the mandible in edentulous segments under removable partial dentures have previously been reported (*Koivumaa*, 1956; *Hedegård*, 1962; *Carlsson et al.*, 1969).

At the 1-year control the Gingival Index was higher for teeth with artificial crowns than for those without. After 2 years, however, the difference was not significant. A comparison *between* the various positions of the crown margins showed that at the 1-year control the Gingival Index was higher when the crown margins were subgingival than when they were supragingival. At the 2-year control there were no differences between the groups. The result of the present longitudinal study appears to point in the same direction as the cross sectional study of patients treated with dental bridges by *Silness* (1970) and experimental studies in dogs and monkeys by *Karlsen* (1970), namely that the risk of clinically demonstrable gingival injury is greatest when the crown margins are placed subgingivally.

The caries activity has been reported to be high in patients with removable partial dentures (*Hansson*, 1955; *Carlsson et al.*, 1965). It is obvious that a partial denture can increase the possibilities of retention of dental plaque in the oral cavity and thereby also the total number of microorganisms. In a few publications interaction has been reported between partial dentures and oral environments. Thus, for example *Onisi* and *Kondo* (1956) reported an increase in the number of lactobacilli of saliva after fitting of acrylic plates in fully dentulous patients. On the other hand, *Nyquist*, *Hansson* & *Glantz* (1971) could not demonstrate any significant increase in the lactobacillus counts in stimulated saliva from patients who had used their partial dentures for 1 month and 1 year, respectively. The findings in the present study of 5 carious lesions in the whole material, including 3 tooth surfaces not in contact with the removable partial denture, do not support the widely accepted but unproven opinion that wearing of a removable denture *per se* will cause an increased frequency of caries.

Some deterioration of the removable dentures had occurred during the 2-year follow-up concerning mainly occlusion, articulation, stability and clasp retention. Relining, grinding of teeth, clasp adjustments and some smaller repairs were undertaken when indicated. The results underline previous recommendations that patients with removable partial dentures should be regularly followed up to enable necessary prosthetic corrections (*Carlsson et al.*, 1965, 1967, 1969).

Most of the patients, 26 out of 29, declared they were satisfied with the dentures, whereas 3 complained of impaired retention. In these latter cases the clasps were adjusted with — according to the patients — instant improvement. In this connection it must be emphasized that the patients' opinion alone cannot be taken as a guarantee that no damage exist since several studies have shown that patients often are unaware of more or less extensive damages (*Koivumaa*, 1956; *Carlsson et al.*, 1965).

In previous longitudinal studies of removable partial dentures high frequencies of damages to biological tissues, particularly in the form of periodontal and carious lesions, have been observed already after short periods (*Koivumaa*, 1956; *Carlsson et al.*, 1965, 1967, 1969). *Carlsson et al.* (1965) concluded that if the treatment is to be successful, removable partial dentures should be provided only for patients from whom cooperation can be expected. In the present study the patients were given individual instruction in oral and denture hygiene and adequate periodontal treatment before the prosthetic therapy was started. The removable partial dentures were carefully planned and designed. The patients were regularly checked, and necessary reinstructions, scaling and prosthetic corrections undertaken. The patients cooperated excellently with no significant deteriorations during the two-year period. Only a few carious lesions were registrated. The present study does not support the opinion that a removable partial denture *per se* will cause periodontal and carious lesions. With a careful planning of the prosthetic treatment and with an adequate oral and denture hygiene, checked up at every clinical visit, little, if any, damage will be caused to the remaining teeth. The present patient material will be continuously followed up.

Acknowledgements. Financial support to this study was given by 'Norrbottens läns landsting, and Swedish Patent Revenue Research Fund. The statistical analysis was performed by Dr. Urban Hjort, Linköping.

REFERENCES

Anderson, J. N., & J. F. Bates, 1959: The cobalt-chromium partial denture. A clinical survey. Brit. Dent. J. *107:* 57—62.

Anderson, J. N., & G. A. Lammie, 1952: A clinical survey of partial dentures. Brit. Dent. J. *92:* 59—67.

Applegate, O. C., 1965: Essentials of removable partial denture prosthesis. W. B. Sanders Co., London.

Bergman, B., G. E. Carlsson, & B. Hedegård, 1964: A longitudinal two-year study of a number of full denture cases. Acta odont. scand. *22:* 3—26.

Björn, H., A. Halling, & H. Thyberg, 1969: Radiographic assessment of marginal bone loss. Odont. Revy *20:* 165—179.

Carlsson, G. E., B. Hedegård, & K. K. Koivumaa, 1961: Studies in partial dental prosthesis: II. An investigation of mandibular partial dentures with double extension saddles. Acta odont. scand. *19:* 215—237.

Carlsson, G. E., B. Hedegård, & K. K. Koivumaa, 1962: Studies in partial dental prosthesis III. A longitudinal study of mandibular partial dentures with double extension saddles. Acta odont. scand. *20:* 95—119.

Carlsson, G. E., B. Hedegård, & K. K. Koivumaa, 1965: Studies in partial dental prosthesis: IV. Final results of a 4-year longitudinal investigation of dentogingivally supported partial dentures. Acta odont. scand. *23:* 443—472.

Carlsson, G. E., N. Ragnarsson, & P. Åstrand, 1967: Changes in height of the alveolar process in edentulous segments. Odont. I. *75:* 193—208.

Carlsson, G. E., N. Ragnarsson, & P. Åstrand, 1969: Changes in height of the alveolar process in edentulous segments: II. Svensk Tandl. Tidskr. *62:* 125—136.

Derry, A., & U. Bertram, 1970: A clinical survey of removable partial dentures after 2 years usage. Acta odont. scand. *28:* 581—598.

Hansson, G., 1955: Partiella mandibulära friändsproteser. Svensk Tandl. Tidskr. *48:* 223—229.

Hedegård, B., 1962: Some observations on tissue changes with immediate dentures. The Dent. Pract. *13:*70—78.

Hupfauf, L., & T. Hupfauf, 1964: Ergebnisse der Nachuntersuchungen bei Patienten mit abgestützten Teilprothesen. Dtsch. zahnärztl. Z. *19:* 369—375.

Karlsen, K., 1967: Partiella plattproteser. Tandteknikern, nr 10.

Karlsen, K., 1970: Gingival reactions to dental restorations. Acta odont. scand. *28:* 895—904.

Koivumaa, K. K., 1956: Changes in periodontal tissues and supporting structures connected with partial dentures. Suom. Hammaslääk. Toim. *52:* suppl. I (Diss.).

Koivumaa, K. K., B. Hedegård, & G. E. Carlsson, 1960: Studies in partial dental prosthesis: I. An investigation of dentogingivally supported partial dentures. Suom. Hammaslääk. Toim. *56:* 461—525.

Krogh-Poulsen, W., 1962: Partielle proteser. Odontologisk Forening, Copenhagen.

Löe, H., & J. Silness, 1963: Periodontal disease in pregnancy: I. Prevalence and severity. Acta odont. scand. *21:* 533—551.

Löfberg, P. G., 1966: Efterundersökning av patienter behandlade med alveolarbarkonstruktion i underkäken. Svensk Tandl. Tidskr. *59:* 81—97.

Markén, K. E., 1962: Studies in deviation between observers in clinico-odontological recording. (Diss.) — Transact. Royal Schools Dent. Stockholm and Umeå, Almqvist & Wiksells, Uppsala, Sweden.

Nyquist, G., L. Hansson, & P.-O. Glantz, 1971: Effect of partial dentures on lactobacillus count in saliva. Odont. Revy *22:* 19—26.

Onisi, M., & W. Kondo, 1956: Establishing an environment for growth of aciduric bacteria in the oral cavity. J. dent. Res. *35:* 596—602.

Seeman, S. K., 1963: A study of the relationship between periodontal disease and the wearing of partial dentures. Austr. Dent. J. *8:* 206—208.

Silness, J., 1970: Periodontal conditions in patients treated with dental bridges. J. periodont. Res. *5:* 60—68.

Silness, J., & H. Löe, 1964: Periodontal disease in pregnancy: II. Correlation between oral hygiene and periodontal condition. Acta odont. scand. *22:* 121—135.

Tomlin, H. R., & J. Osborne, 1961: Cobalt-chromium partial dentures. A clinical survey. Brit. Dent. J. *110:* 307—310.

Addresses:
Bo Bergman,
Department of Prosthetics,
University of Umeå
S-901 87 Umeå,
Sweden

Anders Hugoson,
Department of Periodontology,
Odontologiska kliniken,
Fack, S-400 33 Göteborg 33,
Sweden

Carl-Olof Olsson,
Tandvårdscentralen,
Skeppsbrogatan 22,
S-951 00, Luleå,
Sweden