

Technical failures and some related clinical complications in extensive fixed prosthodontics

An epidemiological study of long-term clinical quality

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Three hundred and sixteen fixed partial dentures made in 1975-1976 by 112 general practitioners in Malmö, Sweden, were selected for a questionnaire study of the technical failure rates after 6-7 years. Cariologic, periodontal, endodontic, and esthetic complications were also identified, as were those appearing in the stomatognathic system. The total material consisted of three groups with an approximately equal number of reconstructions. One group consisted of fixed partial dentures with distal abutment teeth, another was formed of fixed prostheses with single cantilever pontic/pontics, and a third consisted of double cantilever pontics. Excluding the 26 reconstructions, which had been made for patients who died (24) or emigrated (2) during the observation period, data was obtained for 97% of the selected restorations. The results showed high rates of cariologic (18-31%), endodontic (5-23%), periodontal (7-12%), esthetic (10-16%), and technical (8-34%) complications. Differences were noted between the groups. For all types of technical failures (fractures and loss of retention) higher frequencies were related to the extent of cantilevering. Direct relationships were found between the technical failure rate and the time in service, the sum of all cantilever extension pontics in the reconstructions, and the state of the pulps of the distal abutments. No relationship was found between the technical failure rate and the status of the dentition in the opposing jaw. The clinical significance of the results obtained is discussed. □ *Dental clinics; dental prostheses design; denture, partial fixed*

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Increased use of fixed partial dentures has recently been observed in many parts of the Western world. The main reasons for this trend are believed to be a combination of improved oral health, with marked tendency for middle-aged and older persons to retain a relatively high number of their teeth, and the favorable psychological and social benefits of wearing fixed rather than removable prosthetic reconstructions. The cost of fixed partial dentures is often high, which makes the persons involved particularly interested in obtaining the best possible prognoses for such appliances.

In the literature several studies have presented the long-term results of treatments

with fixed dental reconstructions (1-16). In studies in which technical failures were recorded, their frequency was, for example, about 3% after 5 years in a randomly selected population treated by general practitioners in accordance with conventional principles of prosthodontic designing—that is, with an overall mean pontic to abutment relation of 0.5 and with few cantilever pontics (13).

In a population with severe loss of alveolar bone support in whom fixed reconstructions with cantilever pontics were used to splint the remaining teeth and balance the reconstructions, the corresponding frequency was about 8% after 5 to 8 years (10). A similar frequency level seems to have been found by

Karlsson & Hedegård (15, 16) in a study of the long-term outcome of restorative treatments performed by general practitioners.

In recent experimental clinical studies of fixed reconstructions, including one with distal abutments and another with cantilever pontic bars (17), the results showed that the clinical deformation pattern and energy distribution are complex and vary widely between different designs of appliance.

In a population of partially dentate persons, in whom the use of fixed reconstructions has increased, a widening of the range for their indication has probably also taken place, and we believed it to be useful to study the prevalence of technical failures. The technical failures of greatest clinical significance were thought to include fractures of the reconstructions, fractures of the abutment teeth, and loss of retention from abutments. Plans were therefore made to evaluate these types of failure in a group of patients who had been treated with either reconstructions of conventional design or reconstructions having cantilever pontics. It also seemed appropriate to examine possible correlations between technical failures and the status of the abutment teeth, including pulp vitality, caries, endodontic complications, periodontal involvement, and disturbances in the stomatognathic system.

Materials and methods

In Sweden an increased frequency of treatments including extensive fixed reconstructions was observed after the introduction of the National Dental Insurance System in 1974 and was clearly established in the years thereafter (18, 19).

Since 1974 the Swedish Dental Insurance System has provided economic support for and kept records of almost all persons who have received extensive restorative dental care in Sweden. At the Malmö branch of the insurance system the annual number of such patients has been between 3000 and 4000 fixed reconstructions over the period 1974–1976. From this pool 316 fixed partial dentures were selected. They were planned to be provided for 281 patients who were den-

tate in both jaws and required fixed reconstructions. The 316 prostheses were selected from the following three groups: the first consisted of patients in whom distal abutment teeth would be used (group 0); the second was formed from patients whose treatment plans included the use of single cantilever pontic/pontics (group 1); and the third group comprised patients who required reconstructions with double cantilever pontics (group 2). When it had been planned to include bilateral cantilevered reconstructions with different degrees of extension on the two sides, only the more extensive side was included.

Patient selection was made in such a manner that, when possible, every participating dentist who had a patient/patients in one group had an equal number of his/her patients in the other two groups. An initial survey of the three groups showed the third one to be by far the smallest numerically. It was therefore decided to include all the patients in this group and to select an approximately equal number of patients for the other two groups. The total number of selected reconstructions thus became 101 for group 2, 100 for group 1, and 115 for group 0. The reason for the lack of absolute correspondence in the sizes of the three groups was that some dentists who had planned to perform treatments with double-cantilever pontics had not planned an equivalent number of fixed partial dentures with single-can-

Table 1. Age and sex distribution of patients and treating dentists selected for study and year of graduation from dental schools of these dentists

	Men	Women
Patients		
No.	96	145
Age, years	50.59 ± 10.06*	52.54 ± 11.82
Dentists		
No.	100	12
Age, years	41.08 ± 10.29	44.33 ± 12.03
Year of graduation, 1900+	60.53 ± 10.12	58.50 ± 12.01

* Standard deviation.

tilever pontics. On the other hand, some of the patients in the double-cantilever pontic group had more than one conventionally designed fixed reconstruction (group 0) made simultaneously. Since all such reconstructions were included, group 0 became somewhat larger than groups 1 and 2.

In total, 316 reconstructions planned by 112 dentists were selected for this study. All the participating dentists were general practitioners. Since no single dentist had planned treatment with double-cantilever pontics for more than five reconstructions, this became the maximum number of patients per participating dentist and group. The age and sex distribution of the patients and the treating dentists and the year of graduation from dental school are given in Table 1.

Having selected the patients, we contacted the dentists who had planned to perform the described treatments to ascertain whether these had been completed in accordance with the original plans. If annual clinical reviews of these reconstructions had been made, the dentists were asked to fill in a copy of the questionnaire described below. When the performed treatment deviated from the plan to such an extent that the requirements for the individual group were no longer met, the patients were either transferred to the appropriate group or disqualified. When the planned treatment had been performed, but no annual clinical examinations had been made by the dentist responsible for the original treatment, we contacted the patient to ascertain whether he or she had been seeing another dentist/dentists. If so, contact was

Table 2. Fixed reconstructions selected from the records of the Malmö branch of the Swedish Dental Insurance System and some characteristics of the patients concerned. Group 0 represents reconstructions with distal abutment teeth, whereas groups 1 and 2 represent reconstructions with single- and double-cantilever pontics, respectively

	Group 0	Group 1	Group 2
Selected from files, <i>n</i>	115	100	101
A. Originally planned therapy performed, <i>n</i>	108	94	91
1. Clinical follow-ups until 1982, <i>n</i>	92	85	81
2. No clinical follow-ups during the period 1975–1982, <i>n</i>	1	0	1
3. No. of reconstructions from patients deceased during the period 1975–1982	10	7	7
4. No. of reconstructions from patients who refused to participate/refused to respond	3	2	2
5. No. of reconstructions from patients emigrated during the period 1975–1982	2	0	0
B. Originally planned therapy altered to such an extent that the reconstruction was transferred to another group, <i>n</i>	4	5	6
C. No prosthetic therapy performed, <i>n</i>	3	1	2
D. Others*, <i>n</i>	0	0	2
Sum, <i>n</i>	115	100	101
E. From other groups, <i>n</i>	6	7	2
Total sum in clinical group, <i>n</i>	114	101	93
Reconstructions reviewed in 1982, <i>n</i>	98	93	83
Percentage of reconstructions reviewed			
A. From the originally treated group (1975)	86.0	92.1	89.2
B. From the remaining group (1982)	96.1	97.9	96.5

* During the period 1975–1982 one bridge was lost because of extra-oral trauma, and another reconstruction was removed and extended for reasons not related to the original therapy.

made with the 'new' dentist, who was asked to complete the questionnaire.

A total of 10 patients had not seen any dentist during the year preceding this survey. They were advised to do so, but two refused for personal reasons. These two patients agreed to be examined at the school of dentistry in Malmö.

The questionnaire included questions about the design and construction used (conventional gold-acrylic or metal-ceramic reconstructions, veneer crowns, inlays, or pinledge restorations), their extension (number of abutment teeth and pontics), the number of cantilever pontics, if any, the vitality of the distal abutment teeth, and the dental status of the opposing jaw.

Specific questions about technical failures were included. These covered observations of possible loss of retention or fracture of the reconstructions or of the abutment teeth and the position and year of appearance of any such occurrence. When more than one technical failure was reported for an individual reconstruction, only the one judged to be the most severe was recorded—that is, fractures of abutment teeth whenever they occurred, and bridge fractures when the reconstructions had also lost retention. Complications of a cariologic, endodontic, or periodontal nature were also identified, as were those affecting the stomatognathic sys-

tem. Information concerning discolorations, excess wear, and other types of damage to crown and facing materials was also recorded.

With the questionnaire a letter was also sent to the participating dentists, explaining the aim of the investigation and confirming that all collected information would be treated in strict confidence.

The data dealing with patient selection are summarized in Table 2, which also gives the number of reconstructions studied, including those worn by patients who refused to participate, were transferred from one group to another, or had died or emigrated during the period 1975–1982, from which the material was drawn. It also shows that most of the planned treatments had actually been performed (92.7%) even though significant changes in the initial restorative treatment plans were occasionally made (4.8%) during the initial stages.

Twenty-four reconstructions (7.6%) were made for patients who died during the observation period but who were still wearing their reconstructions at the time of death. It was not possible to obtain detailed information about the outcome of the restorative dental treatments that these patients had received in 1975–76. The total group studied consisted of 283 reconstructions, 102 of which belonged to the control group, 95 to the

Table 3. The mean extensions (no. of units) in three groups of fixed reconstructions examined (group 0, with distal abutment teeth; groups 1 and 2, with single- and double-cantilever pontics, respectively), the pontic/abutment ratios, and the percentages of non-vital distal abutment teeth and types of reconstructions (conventional gold/acrylic, conventional gold-porcelain or ceramo-metallic) used in these three groups (n = total no. of reconstructions in each group)

	Type of reconstruction		
	Group 0 ($n = 98$)	Group 1 ($n = 93$)	Group 2 ($n = 83$)
Mean extension (mean no. of units \pm SD)	7.0 \pm 3.2	8.0 \pm 2.8	9.9 \pm 2.2
Pontic/abutment ratio	0.7	0.7	0.7
Non-vital distal abutment teeth*	41.0	46.5	49.5
Conventional gold/acrylic*	87.8	84.9	91.6
Conventional gold/porcelain*	1.0	—	—
Ceramo-metallic*	11.2	15.1	8.4

* Percentage of each group.

group with single-cantilever pontic/pontics, and 86 to the group with double-cantilever pontics.

The number of reconstructions for which data were retrieved was high for all three groups: 96% for the control group, 98% for the experimental group with single-cantilever pontics, and 97% for the experimental group with double-cantilever extensions. None of the contacted dentists refused to participate. The small number of dropouts was due entirely to failure of contacted patients to respond and whose present dentist, if any, could not be identified.

A description of the types of reconstructions studied, their mean extensions, the pontic/abutment ratios, and the percentage of non-vital distal abutment teeth are given by group in Table 3.

From this it can be seen that most of the reconstructions studied were of the conventional gold-acrylic type. The pontic abutment ratio was the same (0.7) for all the studied groups. The mean extensions of the reconstructions in the three groups did not vary to any major extent, especially when the degrees of distal cantilevering for groups 1 and 2 were considered. Finally, there were only minor differences between the percentages of non-vital distal abutment teeth for the three groups. Thus, it is reasonable to conclude that the major systematic biomechanical difference between the groups was related to variations in distal cantilever extension.

The possible influence of the state of the dentition in the opposing jaw on the frequency of technical failures was studied by comparing the population described in Table 2 with a separate Malmö population consisting of all subjects who, in 1975, were wearing complete dentures in one jaw and were treated in the opposing jaw with fixed partial dentures having single- or double-cantilever pontics. Data collection and treatment for these additional groups were the same as those given above. The number of subjects thus treated in Malmö in 1975 was comparatively small: 21 for the single-cantilever group and 19 for the double-cantilever one. Further, the mean age of these patients was somewhat higher than those

Table 4. Number and frequency of technical, cariological, endodontic, periodontal, and esthetic complications in three groups of fixed reconstructions after 7 years (group 0 had distal abutment teeth, whereas groups 1 and 2 had single- and double-cantilever pontics, respectively; *n* = total no. of reconstructions or abutment teeth in each group)

Type of complication	Frequency of complications, %						Total frequency of complications, %	
	Group 0		Group 1		Group 2		Per reconstruction (n = 274)	Per abutment teeth (n = 1297)
Technical	8.2	*	16.1	*	33.7	18.6	*	
Esthetic	11.2	*	9.7	*	15.7	12.0	*	
Cariologic	18.4	20.9	28.0	28.7	31.3	25.5	26.8	
Endodontic	5.1	7.4	8.6	8.9	22.9	11.7	13.6	
Periodontal	10.2	14.0	11.8	14.9	7.2	9.9	11.6	

* Data not calculated because of the possibility of the complication appearing also in pontics.

Table 5. Number of technical failures in reconstructions with both mesial and distal abutment teeth (0), with 1 (1), and with 2 (2) cantilever pontics, respectively

Technical failures	Group 0	Group 1	Group 2
Fractures of reconstructions, <i>n</i>	2	2	8
Fractures of abutments, <i>n</i>	3	4	6
Loss of retention, <i>n</i>	3	9	14
Total no.	8	15	28
No. in each group	98	93	83
Technical failures (%) of the total no. of reconstructions	8.2	16.1	33.7

given in Table 1: 60.19 ± 10.98 years for the single- and 53.50 ± 8.70 years for the double-cantilever group. The number of dropouts was also higher for the patients wearing complete dentures in the opposing jaws (22.7% and 23.8%, respectively), but the reasons for failure to participate were the same as those previously given for the patients with a dentate opposing jaw.

For a small number of the patients (about 10), the original state of the dentition in the opposing jaw underwent major changes during the observation period. In Table 8, which gives the relationship between the rates of technical failures and the state of the dentition in the opposing jaw, these patients are classified by the state of the dentition in the opposing jaw during the major part of the observation period for the individual bridge.

Studies on some possible errors of the method

To minimize the risk of misinterpreting the questions used in the questionnaire, the

meaning and purpose of this study were explained and clarified at professional meetings with the selected groups of dentists.

To test the possibility of misinterpretation, subgroups of the dentists concerned were contacted after answering the questionnaire. No misunderstandings were revealed.

In studies like this, in which the outcome of individual treatments by individual dentists are collected and evaluated systematically, there is a possibility that some failures are not reported for reasons of professional pride.

In connection with the frequent contacts that were made with many patients their opinions on the factors that caused failures and complications were therefore also sought.

In no case did these opinions differ essentially from those given by the examining dentist. It was therefore concluded that the answers given in the questionnaire were basically unbiased and that there was no systematic underrecording of failures.

Table 6. Technical failures of reconstructions with distal abutment teeth (0), with one unilateral single-cantilever pontic (a), with bilateral single-cantilever pontics (b), with unilateral double-cantilever pontics (c), with bilateral single- and double-cantilever pontics (d), and with bilateral double-cantilever pontics (e)

Subgroup (Type of cantilever extension)	Group 0	Group 1		Group 2		
	(0)	a (1 + 0)	b (1 + 1)	c (2 + 0)	d (2 + 1)	e (2 + 2)
No. of reconstructions	98	77	16	39	25	18
No. of technical failures	8	11	4	11	9	8
Technical failures (%)	8.2	14.3	25.0	28.2	36.0	44.4

To study the possible influence of the fact that 30 of the selected patients were represented by more than 1 reconstruction, chi-square analyses (20) were performed on the incidence of complications for all the studied reconstructions and also when these 30 patients had only been assigned 1 randomly selected reconstruction.

The p values found in these analyses were as follows (values given first represent all reconstructions): $p < 0.0005$ and < 0.0005 for technical complications; $p = 0.454$ and 0.607 for esthetic complications; $p = 0.111$ and 0.065 for cariologic complications; $p = 0.001$ and 0.008 for endodontic complications; and $p = 0.587$ and 0.566 for periodontal complications.

The results of these comparative analyses show that the patients with more than one reconstruction had not had any disproportionate influence as far as the rates of technical, esthetic, endodontic, and periodontal complications were concerned. For the rate of cariologic complication a minor statistically insignificant influence was, however, noted. This indicates that, as a group, the above-mentioned 30 patients with more than 1 reconstruction had a somewhat different cariologic activity than the rest of the patients.

Results

The data given in Table 4 are the frequencies of the complications cited in the returned questionnaires. Complications from the stomatognathic system are not included in this because only one such case was reported, and that was in group 0.

As can be seen in Table 4, the single most frequent complication was caries, the prevalence of which also increased by about 50% from group 0 to group 2.

Of the other non-technical complications, endodontic ones were less than 10% in both the control group and the single-cantilever group, whereas in the double-cantilever group it was considerably higher.

A reverse trend was found in the periodontal complications, the frequency of

which was found to be higher in the control group and the single-cantilever group.

In 10% to 16% of the reconstructions noticeable deterioration was reported for the esthetics of the acrylic facing materials.

Finally, the technical failure rates reported for group 1 and 2 were higher than in group 0. To examine further these data, the following steps were taken:

A. The material was divided into three groups, each containing one of the three types of technical failure studied: fractures of the abutment teeth, fractures of the reconstructions, and loss of retention. The results of this analysis are given in Table 5. This table shows the frequency of all types of studied technical failures to be directly related to the degree of cantilever extension.

B. To explore further the data collected on the incidence of technical failures, the following subgroups were created: a) unilateral single-cantilevered reconstructions; b) bilateral single-cantilevered reconstruc-

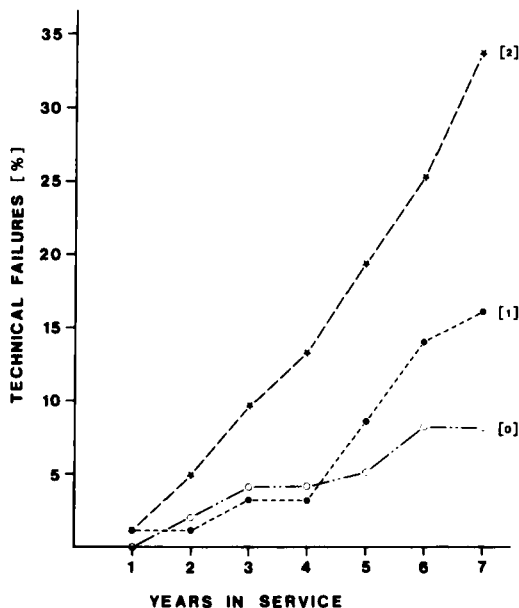


Fig. 1. The frequency (%) of technical failures in a 7-year period in service for extensive fixed partial dentures having no (0), single- (1), and double- (2) cantilever pontics.

Table 8. Relationship between certain technical failures (fractures and loss of retention) in fixed partial dentures with single- or double-cantilevered pontic extensions and the type of dentition of the opposing jaw (N = no. of examined reconstructions; n = no. of reconstructions with technical failures)

Type of dentition in opposing jaw	Control (Group 0)			Single-cantilever extension pontic/pontics			Double-cantilever extension pontic/pontics			All reconstructions with cantilever pontics		
	N	n	%	N	n	%	N	n	%	N	n	%
Complete (dentate or dentally supported appliance)	82	6	7.3	72	12	16.7	68	23	33.8	140	35	25.0
Partial (dentate)	—	—	—	10	1	10.0	6	2	33.3	16	3	18.8
Removable (gingivally supported appliance)	—	—	—	25	4	16.0	22	6	27.2	47	10	21.3

significant relationships between the technical failure rate of cantilevered fixed reconstruction and the type of dentition of the opposing jaw.

To establish the respective levels of statistical significance for the recorded failures and complications, a series of chi-square analyses (20) were performed on the data given in Table 4.

The results of these analyses are given in Table 9, showing, above all, the presence of highly statistically significant differences between the technical and endodontic complication rates between the groups with different degrees of cantilever extension.

By means of the chi-square method, statistical analyses (20) were also performed on

the influence on the technical failure rate of the service time and the type of the dentition in the opposing jaw.

The type of dentition in the opposing jaw did not have any statistically significant relationship with the technical failure rates for reconstructions with cantilever extension pontic/pontics ($p = 0.864$ for group 1, $p = 0.848$ for group 2, and $p = 0.779$ for groups 1 + 2).

For time in service shorter than 3 years no statistically significant relationship could be found between the technical failure rates and the degree of cantilever extension ($p = 0.222$ for year 1 and 0.144 for year 2). At year 3 the p value approached statistical significance ($p = 0.051$) and thereafter con-

Table 9. Probability levels (p) obtained from statistical analyses (chi square) of relationship between the degree of cantilever extension of fixed partial dentures and the frequency of certain clinical complications during a 6- to 7-year observation period

Type of complication	P value	Level of statistical significance
Technical	<0.0005	***
Fractures of reconstructions	0.006	**
Fractures of abutments	0.214	NS
Loss of retention	0.002	**
Esthetic	0.454	NS
Cariologic	0.111	NS
Endodontic	0.001	***
Periodontal	0.587	NS

tinued to fall into the range of high statistical significance ($p = 0.004$ for year 4, $p = 0.002$ for years 5 and 6, and $p < 0.0005$ for year 7).

Discussion

In the Western world the use of extensive fixed reconstructions in the treatment of partially dentate persons has increased during the last 2 decades. Because extensive reconstructions, particularly those including cantilever extensions, may result in the creation of complex biomechanical situations (17), it was considered worthwhile to perform an epidemiologic survey of the prevalence of technical failures in connection with extensive fixed prosthodontic treatments. It was also of interest to include important non-technical complications such as those of a cariological, periodontal, and endodontic nature.

The geographic area selected was the city of Malmö, Sweden (population, approximately 240,000). Although limited in extent, no noticeable differences have been observed either in the prevalence of biomaterial reactions or in the clinical quality of fixed prosthodontics between the Malmö area and two counties (Örebro län and Kronobergs län) located in other parts of Sweden (13, 21). Sweden is one of the countries in which extensive fixed prosthetic treatment is frequently practiced by general practitioners (19), and there is no reason to believe that the competence to perform such treatment should be generally lower among Swedish general practitioners and dental laboratories than in other parts of the world. The selected area and population for this study was therefore considered to have general validity.

Collection of data through surveys is generally regarded as being a method with questionable accuracy and precision. The return frequency was very high in this study, ranging from 96% to 98% in the studied groups, and it was also established that there was good understanding among the responding dentists about the interpretation of the questions posed. Therefore and because the criteria were both clearly defined and precise,

especially in relation to technical failures, it is reasonable to conclude that the survey gave a fair view both of the prevalence of technical failures in extensive prosthodontics and of other types of clinical complications possibly related to such treatments.

The population studied was not randomly selected because of the relative infrequency with which fixed partial dentures with double-cantilever pontics were placed. Because the studied groups were created so as to minimize the influence of the professional skill of the participating dentists and because the number of such dentists was large and therefore obviously representative of the group of general practitioners in Malmö with an interest in fixed prosthodontics, the method used for patient selection was believed to be valid and accurate. Furthermore, it was also established that individual patient variations had no major negative influence on the validity of this study.

Caries was the single most frequent complication observed. A high frequency of new caries attack is in agreement with observations previously made by Glantz et al. (13) and Karlsson & Hedegård (16). It indicates that in the planning stages of restorative treatment more attention and effort should be directed towards the identification of high caries-risk subjects and control of caries-promoting factors such as diet and the implementation of caries-preventing measures.

In the control and single-cantilever pontic groups the rate of endodontic complications was 7–9%. These results and the total prevalence of endodontic complications were in accordance with the data given by Kerekes & Bervell (22) and Bergenholtz & Nyman (23) and probably reflect the diagnostic and therapeutic problems associated with the use of vital teeth as veneer crown abutments. Compared with the other two groups examined, the double-cantilever pontic group showed a considerably increased frequency of endodontic complications. This probably reflected the endodontic consequences of the fact that in extensive fixed partial dentures, excessive preparations are often made on distal abutment teeth to ensure retention of distal abutment crowns (24).

Periodontal complications appeared in

between 7% and 15% of the patient groups. The lower frequency noted for the double-cantilever group probably reflected the fact that this rehabilitative procedure was originally developed for cases with reduced alveolar bone support (25-27). Such groups of patients are often put on special hygiene programs, which could explain the lower frequency of periodontal complications.

By comparison, a very low frequency was noted for disturbances in the stomatognathic system (28-30). This could be due to a lack of diagnostic competence by the participating dentists. However, it is not the most likely explanation, as symptoms and disturbances initiated in the stomatognathic system probably would have been revealed by the patients sooner or later during the long examination period. It is more likely that the low frequency observed was due to the fact that incipient symptoms that may have become established in the stomatognathic system disappeared as a result of the restorative treatment performed.

All the recorded esthetic complications

were due to discoloration or excessive wear of acrylic facings. This esthetic complication rate is more than 10 times higher than that reported in a recent 5-year follow-up study (13). The difference could be due to many factors, such as the use of different criteria or the existence of true differences in the quality of the facing materials used. Since they are closely related with regard to both the time and place of their manufacture, it is, however, most likely that the main reason for the observed difference is the relatively poor color stability and wear resistance of many acrylic materials used for making facings. This observation is supported by the laboratory data presented by Ruyter (31) of various types of methacrylate-based dental materials. The 2-year time difference between the 5-year observation period reported by Glantz et al. (13) and the 7 years of this study thus seems to represent the time of onset of frequent clinically noticeable degradations of acrylic facing materials made in the mid-1970s.

The present study shows that over a period

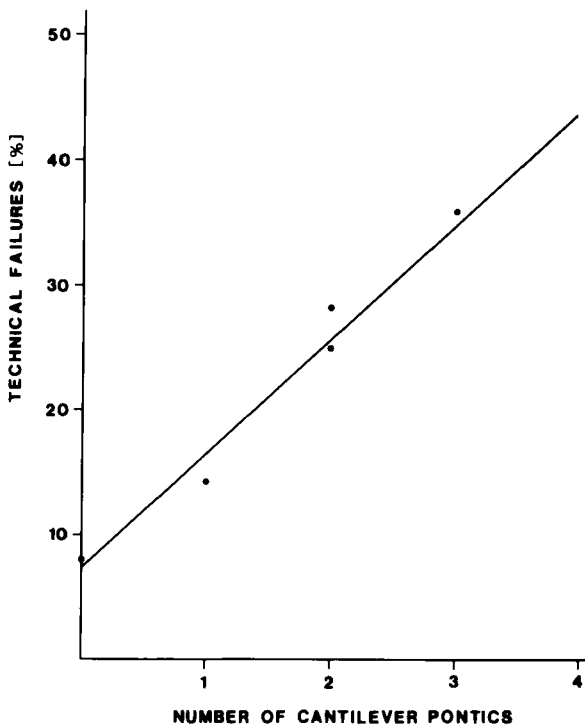


Fig. 2. Relationship between the frequency (%) of technical failures (fractures and loss of retention) after 7 years in extensive fixed reconstructions and the number of all cantilever extension pontics in these reconstructions.

of 6 to 7 years there was a high rate of technical failures when extensive fixed partial dentures were provided by general practitioners (Tables 4, 5, and 6). This was particularly so for the group of reconstructions with double-cantilever pontics. Generally speaking, even if the methods used for data collection had been markedly different, this noted trend of technical failure rates points in the same direction as that given by Bäcklund & Åkesson (2) and Karlsson & Hedegård (15, 16). Although lower failure rates have been reported for similar types of reconstructions used in association with periodontal therapy (10), it was essential to establish whether major differences could have been present in the populations studied.

In doing so, it became evident that Nyman & Lindhe (10) had studied the outcome of extensive prosthodontic therapy in patient groups in which multiple cantilever pontic units were used to stabilize and splint teeth with markedly reduced alveolar bone support. As has been discussed in detail by Glantz & Nyman (26), such a patient group constitutes a special population in which extensive prosthodontic treatment is facilitated mainly because the risks for functional stress concentrations in the appliances themselves are reduced and because compensatory increases of the critical dimensions of the reconstructions can be made more easily on teeth with reduced alveolar bone support. The population selected for this study was evidently less homogeneous and included subjects who also had dental diseases other than periodontal ones (Table 4). In subjects who had lost their teeth because of dental caries, the anatomic and functional conditions were fundamentally different, posing increased difficulties in avoiding functional stress concentrations in the appliances, the luting cements, and/or the abutment teeth.

The results given in Table 6 show that there was a direct relationship between the rate of technical failures and the sum of all cantilever pontics. Thus, if it is assumed that cantilever units have approximately the same mesiodistal dimensions, an almost fully linear relationship can be established between the frequency of technical failures and the

sum of all cantilever extension pontics in the reconstruction (Fig. 2). The data given in Fig. 2 deviate only marginally ($p = 0.93$) from a hypothetical linear trend when calculated by a chi-square-based trend test (20). In cross-arch reconstructions, contrary to what has occasionally been suggested, a balanced action minimizing the risk of technical failures will *not* be reached when bilateral cantilever pontic segments are used. Instead, there will be a direct summation effect from all the cantilever pontics in the reconstruction. These are conclusions contrary to the ones drawn by Laurell (32) from experimental studies of the magnitude of axially directed forces. The contradictory conclusions between this study and that of Laurell could probably be explained by the fact that in cantilevered fixed partial dentures Glantz et al. (17) have shown that the major functional deformation took place in directions deviating greatly from the axial one.

In clinical experiments Randow & Glantz (33) have recently shown that non-vital teeth withstand higher cantilever load levels than vital teeth before marked discomfort pain sensations appear. Here, loss of retention and fractures of both teeth and reconstructions appeared more frequently when the distal abutments were non-vital (Table 7). This high frequency of fractures to non-vital abutment teeth is in accordance with observations made by Nyman & Lindhe (10), Karlsson & Hedegård (16), and Sorensen & Martinoff (34). Even though it was possible that the dentine of the non-vital teeth was more brittle and that cement retention was impaired in the non-vital teeth, it is not reasonable to assume that the lack of vitality of certain distal abutment teeth had a negative influence on the strength of the fixed partial dentures themselves. Rather, it is more realistic to assume that the high frequency of fractures of the reconstructions, teeth, and luting cements was caused by systematic relative overstraining when the distal abutment teeth were non-vital. This view is supported by the observation of a time dependence for these types of fracture, indicating that fatigue probably is a phenomenon of major importance (Fig. 1). Consequently, because of the increased periods of func-

tional contacts in patients with bruxism, extensive cantilevered fixed partial dentures should perhaps be avoided in this group, particularly when the distal teeth are root-filled.

A large majority of the recorded fractures of the reconstructions occurred in the region immediately mesial to the distal abutment teeth. This is the area where Glantz et al. (17) have shown that stress concentrations appear during functional loading of strain-gauged cantilevered fixed partial dentures, thus linking the findings of experimental clinical studies with those of this epidemiological one. These findings point to the necessity for production laboratories to concentrate on and improve the dimensions and material qualities of this area of fixed partial dentures with cantilever pontics.

Very similar technical failure frequencies were observed where the cantilevered reconstructions made functional contact with a dentate opposing jaw, when the mucosa of this jaw was supporting a removable appliance (generally a complete denture) or even when there were no apparent functional contacts with the cantilever pontic segments. This somewhat unexpected finding was probably due to the fact that every well-supported and stable complete denture could show high functional loading levels (35) and that cantilever pontic units without any opposing teeth can probably be exposed to high loadings both during chewing and during muscular hyperfunction, for example, by the tongue. This is a conclusion in accordance with the results presented by Izikowitz (6, 7, 14) in studies of the long-term outcome of treatment with so-called saddle extension bridges.

Summing up, there seemed to be several strong correlations between the rate of technical failures in extensive fixed prosthodontics and certain clinical criteria. Thus, the use of multiple cantilever pontic segments in fixed reconstructions did seem to be associated with higher risks when non-vital teeth were used as the distal abutment and when the reconstructions were subject to prolonged functional contacts.

The existence of a balanced bilateral extension—that is, cantilever pontics on both

sides of a reconstruction—obviously does not reduce but increases the risk for technical failures. The state of the dentition of the opposing jaw obviously had little influence on the technical failure rate.

In this context it must be remembered that, even in the group with the technologically most advanced reconstructions, after 7 years there was still a higher rate of success than failure. The use of fixed reconstructions with multiple cantilever pontics must therefore be regarded by general practitioners as a realistic but demanding alternative to removable partial dentures in the treatment of partially dentate subjects with a uni- or bi-lateral tooth loss in posterior segments. The alternative to fixed reconstructions is to use removable partial dentures with free end saddles. Free end-saddle partial dentures have long been known to be associated with high rates of both technical and biological complications and failures and therefore offer few advantages (36–40).

A more careful analysis of the biological and technological conditions existing in individual patients in the future will probably lead to a situation in which the failure rate will be reduced for extensive fixed prosthodontics with cantilever pontics and the expansion of a fixed prosthodontic service will be promoted.

Finally, in relation to the factors studied here, there are others that could influence the rate of technical failures, such as the type of material used in the production of fixed partial dentures. The collected material included too few ceramo-metallic restorations (12%) to enable a planned comparison to be made with conventional gold-acrylic ones. Two factors that were not investigated because the data were not available were the vertical dimension for occlusion and cuspal configuration. These factors and others will be studied in the future.

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