An 18-Year Retrospective Analysis of Treatment Outcomes with Metal-Ceramic Fixed Partial Dentures

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Purpose: The aim of this clinical retrospective study was to evaluate the survival and success rates of metal-ceramic fixed partial dentures (FPDs) made by dental students over an 18-year interval. Biologic and technical complications as well as patient satisfaction were recorded. ***Materials and Methods:*** Fifty-seven patients with 82 FPDs from an original group of 104 patients with 128 FPDs attended an approximate clinical 18-year follow-up examination. The mean follow-up period was 17.7 years (range: 17.1 to 21.3 years). ***Results:*** Nine FPDs were lost because of extraction of an abutment tooth, and 1 FPD was removed for esthetic reasons. Technical problems recorded included loss of cementation, fractures in the metal framework, and need for placement of a dowel in an abutment tooth. The most common clinical findings were gingival bleeding on probing and appearance of supragingival crown margins. The survival rate of the FPDs was 78%, and the established success rate was 71%. ***Conclusion:*** This 18-year follow-up of metal-ceramic FPDs in just over half of the originally treated patient group was associated with good patient satisfaction and few biologic and technical complications. *Int J Prosthodont 2011;24:314–319.*

Metal-ceramic fixed partial dentures (FPDs) have been prescribed for decades and continue to be regarded as routine treatment modalities in addition to more current all-ceramic FPDs. This appears to be a clinical reality in most dental school curricula, in spite of the successful development of alternative implant options. Nonetheless, few studies have evaluated the survival and successful treatment outcomes of metal-ceramic FPDs over prolonged time periods. Reported survival rates of FPDs have varied from 65% to 79%,[1–8] with observed complications that included caries, loss of abutment vitality, compromised retention, poor esthetics, technical problems (fractures of the FPD, porcelain fractures, occlusal tooth wear), and periodontal disease.[1–9]

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Meta-analyses have been attempted in an effort to combine the survival rates of multiple studies to diminish variation. Creugers et al[10] calculated the survival rate to be 74% after 15 years, while Scurria et al[11] reported a survival rate of 92% after 10 years and 75% after 15 years. Others, including Tan et al,[9] calculated that the 10-year survival probability for FPDs was 89.1% (95% confidence interval [CI]: 81% to 93.8%) and the probability of success was 71.1% (95% CI: 47.7% to 85.2%).

The aim of this retrospective clinical study was to evaluate defined survival and success rates of metal-ceramic FPDs made by dental students after 18 years. Biologic and technical complications as well as patient satisfaction were recorded.

Materials and Methods

Between 1984 and 1987, a total of 104 patients (68 women and 36 men, mean age: 42.2 years, range: 25 to 66 years) were treated with 128 metal-ceramic FPDs by dental students at the Institute of Dentistry, University of Oulu, Oulu, Finland. All metal-ceramic FPDs were included in the study; acrylic resin veneer FPDs and all-ceramic FPDs were excluded. Patient data were collected from the patient files of the Institute of Dentistry. Identical inclusion and exclusion criteria and treatment guidelines, confirming

Table 1 Length of FPDs in Patients Treated

	Patients treated 1984–1987		Patients followed for 18 years	
	n	%	n	%
3 units	55	43.0	37	44.5
4 units	40	31.2	24	29.6
5 units	27	21.1	16	19.8
6 units	5	3.9	4	4.9
7 units	1	0.8	1	1.2
Total	128	100.0	82	100.0

Table 2 Distribution of FPDs in Different Follow-up Periods

Follow-up	n	%
17 years	11	13
18 years	27	33
19 years	23	28
20 years	16	20
21 years	5	6
Total	82	100

that established and traditional prosthodontic protocols taught internationally were also taught at the Institute of Dentistry, were used, and every treatment phase was checked by university-appointed clinical instructors using the same criteria.

The 128 FPDs were prepared on 326 abutments with 179 pontics. The mean FPD length was 3.9 units (range: 3 to 7 units) (Table 1). Patients received periodontal treatment before prosthetic treatment, including motivation, instruction in oral hygiene, and scaling. One recall appointment was held 6 months after treatment. Thereafter, patients were advised to seek dental treatment outside the institute.

In 2005, all treated patients were invited to a clinical examination after an approximate follow-up period of 17.7 years (range: 17.1 to 21.3 years) (Table 2), and 57 patients (55%) from the original group agreed to participate in the study. Nonparticipants were not re-contacted by telephone or letter for information about their prostheses. The study group comprised 39 women (68%) and 18 men (32%) with a mean age of 61.1 years (range: 44 to 85 years) at the time of examination. Altogether, 82 FPDs were examined, representing 64% of FPDs made between 1984 and 1987. The mean length of the FPDs was 3.7 units (range: 3 to 7 units, Table 1), and they originally included 202 abutment teeth and 111 pontics (108 pontics and 3 cantilever pontics), of which 162 abutment teeth were present at the clinical examination. The preparations made in abutment teeth were chamfer preparations (81 abutment teeth, 50%) and facial shoulder preparations (81 abutment teeth, 50%). The distribution of abutment teeth and pontics is presented in Figs 1a and 1b. The occluding dentitions are presented in Table 3. The cements used were zinc-phosphate cement (66 FPDs, 81%), glass-ionomer cement (11 FPDs, 13%), and polycarboxylate cement (5 FPDs, 6%).

All follow-up examinations were carried out by the same examiner, who is a qualified prosthodontist. Data on background factors were obtained using questionnaires and interviews in conjunction with a clinical examination; systemic and dental histories (including the time of possible complication) were recorded together with patient opinions about esthetics (scale: 0 = good, 1 = poor), pain, sensitivity to cold or heat, root sensitivity, and gingival bleeding related to the abutment teeth (scale: 0 = not present, 1 = present). At the clinical examination, the periodontal condition of the abutment teeth (bleeding on probing and periodontal pockets over 4 mm), location of the FPD margins related to the gingival margins in abutment teeth, and caries/restorations in abutment teeth were evaluated. The crown margin excess and marginal fidelity (the border between the crown and the tooth) were examined using a probe. Visible occlusal tooth wear of both FPDs and opposing teeth, deterioration of the border between porcelain and metal, and porcelain fractures were all recorded (scale: 0 = not present, 1 = present; cohesive/adhesive fracture not specified). Radiographic evaluation of the abutment teeth was completed using intraoral radiographs, and periapical pathology, the quality of root filling, and root resection were recorded. Dental treatment during prosthetic treatment and possible treatment given after completion of the prosthetic treatment at the Institute of Dentistry was checked for in the patients' files.

The longevity of the FPDs was counted from the day of original cementation to the day of an identified complication; if no complications occurred, it was counted to the day of the clinical follow-up examination. A Kaplan-Meier survival analysis was performed on the basis of these facts. Survival was defined as an FPD that was in situ at the examination visit,

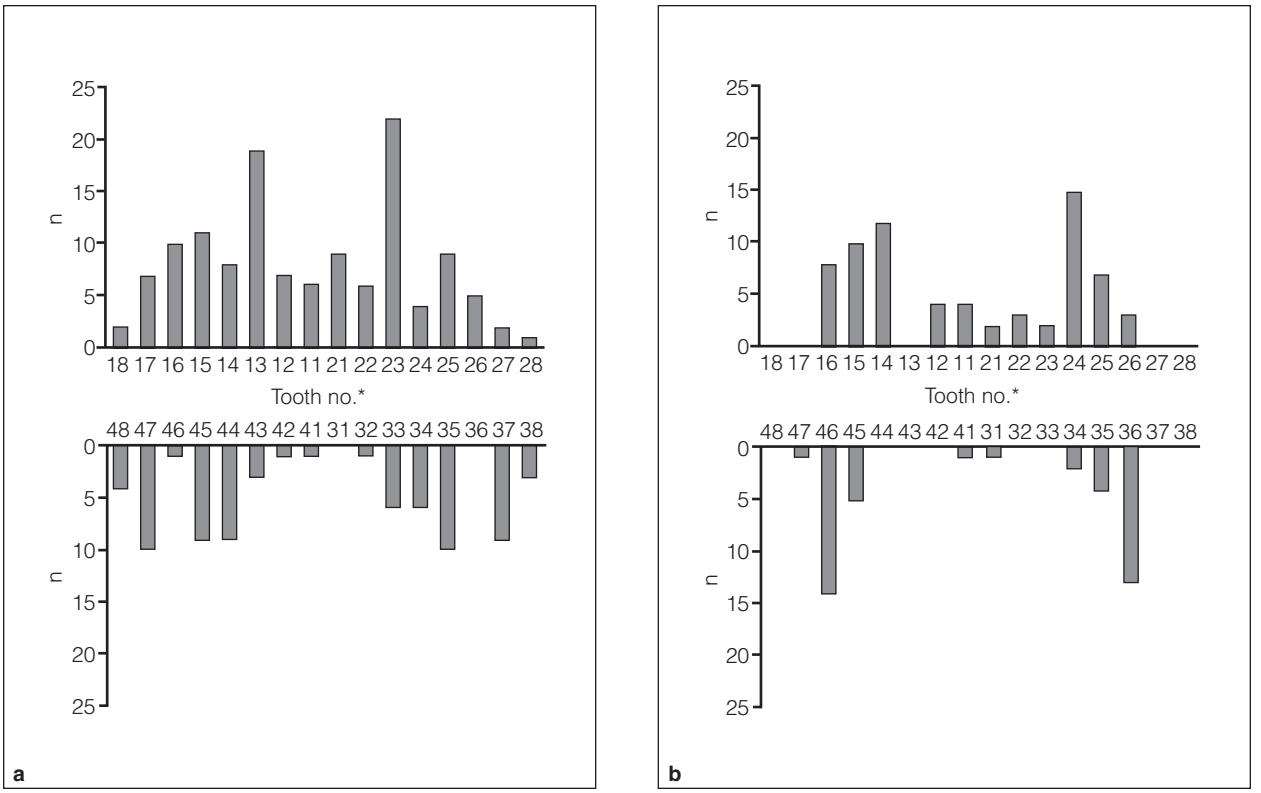

Fig 1 Distribution of **(a)** abutments and **(b)** pontics in the 82 FPDs. *FDI tooth-numbering system.

Table 3 Occluding dentition of FPDs

	n	%
Own teeth	56	68
Fixed prostheses, conventional	17	21
Removable partial denture	7	9
Complete denture	1	1
Implant-supported fixed prostheses	1	1
Total	82	100

Table 4 Distribution of Technical Failures in 82 Metal-Ceramic FPDs

	n	%
No complication	67	82
Porcelain fracture	13	16
Extraction of an abutment tooth	9	11
Fracture in the metal framework	5	6
Recementation	2	2
Dowel placed in an abutment tooth	1	1
Renewal for esthetic reasons	1	1

irrespective of its condition (according to Tan et al[9]). Success was defined as an FPD that had remained asymptomatic and unchanged over the observation period, as per Tan et al.[9] The log-rank test was performed to compare the survivals of short (3 to 4 units) and long (5 to 7 units) FPDs and the distribution of FPDs in the maxilla and mandible as well as in men and women.

Approval of the study protocol was obtained from the ethics committee of Oulu University Hospital, Oulu, Finland.

Results

Nine FPDs (11%) were lost as a result of extraction of the abutment tooth (Table 4); the regions of all complications are listed in Table 5. Porcelain fracture was evident in 13 FPDs (16%), and 5 FPDs (6%) had a fracture in the metal framework. Two FPDs (2%) were recemented, and 1 FPD was reconstructed for esthetic reasons. A dowel was placed in 1 abutment tooth because of endodontic problems; the FPD was removed for endodontic treatment and placement of the dowel.

Table 5 Distribution of Technical and Biologic Complications in Dentition and Treatment After Failure

Failure	Region of FPD*	Treatment after failure
Extraction of abutment tooth	35, 36, 37	Extraction of tooth 35
Extraction of abutment tooth	11, 21, 22, 23	Renewal of FPD
Extraction of abutment tooth	13, 14, 15, 16, 17	Renewal of FPD
Extraction of abutment tooth	23, 24, 25	Extraction of tooth 25, replaced with implant
Extraction of abutment tooth	13, 14, 15, 16	Extraction of teeth 15 and 16, replaced with removable prosthesis
Extraction of abutment tooth	35, 36, 37	Extraction of tooth 35, replaced with implant
Extraction of abutment tooth	23, 24, 25, 26	Cut of FPD in place of fracture in region of tooth 26
Extraction of abutment tooth	15, 16, 17	Extraction of tooth 15, replaced with implant
Extraction of abutment tooth	43, 44, 45	Extraction of abutment teeth for periodontal reasons, replaced with removable prosthesis
Fracture in metal framework	13, 12, 11, 21, 22, 23	FPD in use with existing fracture
Fracture in metal framework	13, 12, 11, 21	Soldered joint
Fracture in metal framework	16, 15, 14, 13	Soldered joint
Fracture in metal framework	16, 17, 18	Cut of FPD in place of fracture
Fracture in metal framework	33, 34, 35, 36, 37	Renewal of FPD
Recementation	12, 13, 14, 15, 16	Recementation
Recementation	35, 36, 37	Recementation
Dowel placed in abutment tooth	13, 14, 15, 16	Dowel placed in tooth 13, recemention
Renewal for esthetic reasons	45, 46, 47	Renewal of FPD

*FDI tooth-numbering system.

Table 6 Periodontal Findings in Abutment Teeth

	n	%
Gingival bleeding on probing	39	24
Periodontal pockets (4–6 mm)	12	8
Crown margin excess	16	10
Buccal crown margin		
Supragingival	95	59
Marginal	61	37
Subgingival	6	4
Palatal crown margin		
Supragingival	41	25
Marginal	117	72
Subgingival	4	3

Table 7 Cariologic Findings in Abutment Teeth

	n	%
No caries	154	95
Caries lesion	0	0
Restoration in the crown margin	8	5
Total	162	100

Table 8 Technical Problems in Abutment Teeth

	n	%
Inappropriate marginal fidelity	8	5
Occlusal tooth wear		
Crowns	17	10
Opposing teeth	11	7
Wear in the border between porcelain and metal	2	1

In the follow-up, 98% of subjects had no complaints about the esthetics of their FPDs. Subjects felt pain (6%), sensitivity to cold (6%), sensitivity to heat (5%), root sensitivity (11%), and saw gingival bleeding (16%).

Gingival bleeding on probing was found in 24% of abutment teeth, and periodontal pockets (4 to 6 mm) were found in 8% of the abutment teeth (Table 6). The buccal crown margin was supragingival in 59% and the palatal crown margin in 25% of abutment teeth. Caries lesions were not found in abutment teeth (Table 7); restorations were evident in 8 of 162 abutment teeth (5%). Marginal fidelity was not satisfactory in 5% of abutment teeth (Table 8). Visible occlusal tooth wear was found in 10% of abutment teeth and in 7% of opposing teeth. All FPDs were cemented tightly and not mobile.

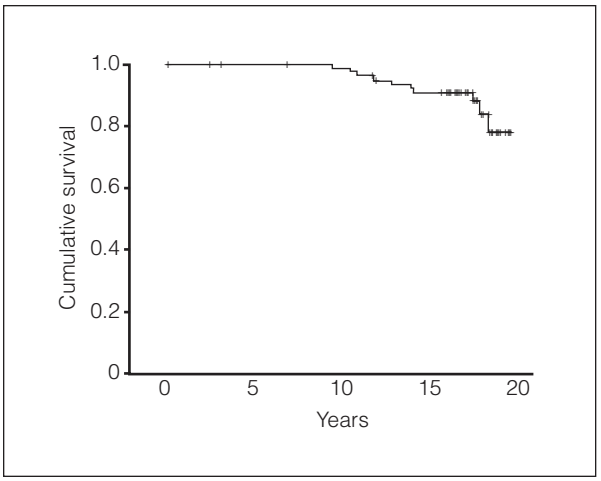

Fig 2 Survival of the metal-ceramic FPDs was 78% (95% CI: 76.5% to 79.5%). FPDs that did not survive were lost because of extraction of the abutment tooth, fracture in the metal framework, or improper esthetics.

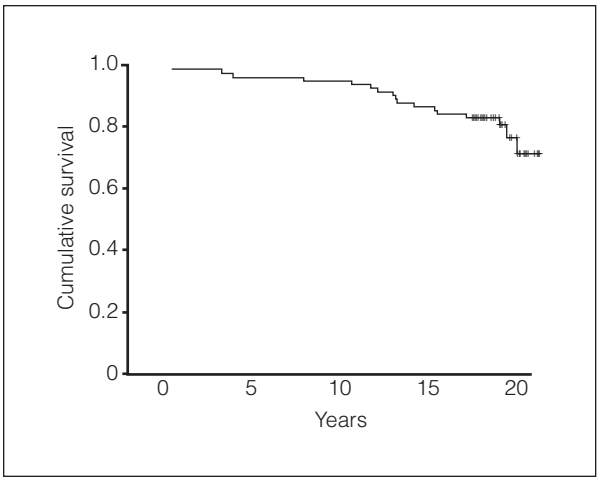

Fig 3 Success of the metal-ceramic FPDs was 71% (95% CI: 69.5% to 72.5%). FPDs counted included those that were repaired (recementations, porcelain fractures) or those lost because of extraction of the abutment tooth, fracture in the metal framework, or improper esthetics.

A radiologic examination was performed for 92% (149 of 162) of clinically examined abutment teeth; 6 patients refused examination (13 of 162 abutment teeth, 8%). Periapical pathology was found in 7% (11 of 162) of abutment teeth. A root resection was performed in 3 of 162 abutment teeth (2%).

The survival rate of the FPDs after 18 years was 78% (95% CI: 76.5% to 79.5 %) (Fig 2), and the success rate was 71% (95% CI: 69.5% to 72.5%) (Fig 3). There were no differences in the survival or success rates between short (3 to 4 units) and long (5 to 7 units) FPDs, between the maxilla and mandible, or in men or women (Table 9).

Table 9 Survival and Success Rates

	n	Survival	Success	*P**
Short (3 to 4 units) FPDs	61	0.73	0.70	
Long (5 to 7 units) FPDs	21	0.79	0.75	.48
Maxilla	51	0.75	0.72	
Mandible	31	0.71	0.68	.82
Women	58	0.73	0.70	
Men	24	0.75	0.72	.20

*Log-rank test.

Discussion

The survival rate of the metal-ceramic FPDs was 78%, and the success rate was 71% over the observational time frame. The results are comparable to earlier long-term studies that were carried out over 15 years.[1–8] The most common technical complications were fractured abutment teeth, porcelain fractures, and metal framework fractures. Biologic findings were related mostly to gingival bleeding on probing and supragingival crown margins. Caries or restorations in abutment teeth were not a problem in this study, and this also has been found in previous studies,[12] contrary to earlier follow-up studies on conventional fixed prostheses.[9,13,14] Also, in the study by Sharma,[15] technical complications in FPDs were more common than biologic ones. At the Institute of Dentistry, it is not possible to arrange regular recall examinations for FPD patients, and patients are advised to seek dental treatment outside the institute. In the follow-up examination, 44% of patients reported annual recall, 10% reported that they visited the dentist more than annually, and 6% had not seen a dentist since the FPD was prepared (18 to 21 years). This study is a retrospective cross-section study, and results were based on data recorded at the single clinical examination. Therefore, the limitations of the results are related to missing data concerning the time of prosthetic delivery, for example, crown margin placement and gypsum models to see the occlusal wear.

This study found no difference related to survival and success between short and long FPDs. After 18 years, the survival rate was 73% for short (3 to 4 units) FPDs, which is similar to that found in the study by De Backer et al,[13] who estimated the survival rate of short FPDs to be 70.8% after 20 years. On the contrary, De Backer et al[13] estimated the survival rate of long (5 or more units) FPDs to be 52.8% after 20 years.

In this study, the survival rate of 5- to 7-unit FPDs was 79% after 18 years. In an earlier 10-year follow-up study by the same authors,[12] it was found that FPDs that had 6 or more units had a lower survival rate, but the variation seemed to diminish over time.

The difference in survival between the 10-year follow-up[12] and the 18-year follow-up (current study) was 84% versus 78%. It has been shown that survival may decrease more sharply after 10 years,[14] which could partly be explained by fatigue in the materials used, such as metal alloys, porcelain, and cement.[10] Biologic reasons, eg, retainer loosening and recurrent caries, can also decrease survival after 10 years.[11] To find complications and treat them as early and as easily as possible, regular follow-up examinations of FPDs are naturally very important.

Only a few patients had technical or biologic subjective complaints. From an esthetic point of view, the supragingival and marginal crown margins may be relevant for the patients in the case of the metal framework, which may be visible beside the margin of the FPD, although in half of the abutments the porcelain shoulder was prepared on the buccal aspect of the abutment. However, most patients mentioned no complaints regarding esthetics, and only one FPD was renewed for esthetic reasons. In the clinical examination, the periodontal condition of the abutment teeth was generally good. Although gingival bleeding on probing and 4- to 6-mm periodontal pockets were found, no FPDs were lost for periodontal reasons. The weakness of the results is that the periodontal changes were not compared to uncrowned contralateral teeth.

In this study, 55% of target subjects representing 64% of FPDs made between 1984 and 1987 attended the follow-up. The sample is rather small but all patients treated with FPDs in the selected time period were sent an invitation to the clinical examination, and no power analysis of the sample size was required. The long follow-up period had an effect on participation in the study: many patients had moved out of the region, could not be reached, or had died. One reason for not attending the study could have been loss of or dissatisfaction with the FPDs, and this could have affected the results.

Conclusions

Within the limitations of this long-term observational research design, it may be stated that metal-ceramic FPDs made by closely supervised dental students demonstrated a survival rate of 78% and a success rate of 71%. Biologic and technical complications found in the clinical examination were few, and the patients were satisfied with their FPDs. The survival and success rates of the FPDs after 18 years were not influenced by the length of the FPDs or the distribution of the FPDs in maxilla and mandible.

References

1. Valderhaug J. A 15-year clinical evaluation of fixed prosthodontics. Acta Odontol Scand 1991;49:35–40.
2. Glantz PO, Nilner K, Jendresen MD, Sundberg H. Quality of fixed prosthodontics after 15 years. Acta Odontol Scand 1993;51: 247–252.
3. Palmqvist S, Swartz B. Artificial crowns and fixed partial dentures 18 to 23 years after placement. Int J Prosthodont 1993; 6:279–285.
4. Libby G, Arcuri MR, LaVelle WE, Hebl L. Longevity of fixed partial dentures. J Prosthet Dent 1997;78:127–131.
5. Sundh B, Ödman P. A study of fixed prosthodontics performed at a university clinic 18 years after insertion. Int J Prosthodont 1997;10:513–519.
6. Lindquist E, Karlsson S. Success rate and failures for fixed partial dentures after 20 years of service: Part I. Int J Prosthodont 1998;11:133–138.
7. Holm C, Tidehag P, Tillberg A, Molin M. Longevity and quality of FPDs: A retrospective study of restorations 30, 20, and 10 years after insertion. Int J Prosthodont 2003;16:283–289.
8. De Backer H, Van Maele G, De Moor N, Van den Berghe L, De Boever J. A 20-year retrospective survival study of fixed partial dentures. Int J Prosthodont 2006;19:143–153.
9. Tan K, Pjetursson BE, Lang NP, Chan ESY. A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years. Clin Oral Implants Res 2004;15:654–666.
10. Creugers NHJ, Käyser AF, van't Hof MA. A meta-analysis of durability data on conventional fixed bridges. Community Dent Oral Epidemiol 1994;22:448–452.
11. Scurria MS, Bader JD, Shugars DA. Meta-analysis of fixed partial denture survival: Prostheses and abutments. J Prosthet Dent 1998;79:459–464.
12. Näpänkangas R, Salonen-Kemppi MA, Raustia AM. Longevity of fixed metal ceramic bridge prostheses: A clinical follow-up study. J Oral Rehabil 2002;29:140–145.
13. De Backer H, Van Maele G, De Moor N, Van den Berghe L. Long-term results of short-span versus long-span fixed dental prostheses: An up to 20-year retrospective study. Int J Prosthodont 2008;21:75–85.
14. Karlsson S. Failures and length of service in fixed prosthodontics after long-term function. A longitudinal clinical study. Swed Dent J 1989;13:185–192.
15. Sharma P. 90% of fixed partial dentures survive 5 years. How long do conventional fixed partial dentures (FPDs) survive and how frequently do complications occur? Evid Based Dent 2005;6:74–75.