Twenty-Year Follow-up of Metal-Ceramic Single Crowns: A Retrospective Study

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Purpose: The aim of this clinical retrospective study was to evaluate the survival and success of single metal-ceramic crowns after 20 years. The biologic and technical complications as well as patient satisfaction were recorded. ***Materials and Methods:*** Fifty patients treated with 100 single metal-ceramic crowns attended the clinical 20-year follow-up examination. The mean follow-up time was 18.8 years (17.5 to 20.5 years). ***Results:*** Twenty-one teeth with single crowns were extracted because of root fractures or esthetic or periodontal reasons. Ninety-seven percent of the subjects had no complaints about the esthetics of the crowns. The most common clinical findings were supragingival crown margins caused by gingival recessions, gingival bleeding on probing, and occlusal wear in opposing teeth. The success of the crowns after 20 years was 75%, and the survival was 78%. ***Conclusion:*** In the 20-year follow-up of single metal-ceramic crowns, there were few biologic and technical complications, and patients were satisfied with the crowns. Crown removal was in most cases the result of root fractures in single crowns with endodontic posts. *Int J Prosthodont 2008;21:307–311.*

Most long-term studies focus on fixed partial dentures, whereas the survival of metal-ceramic single crowns has been evaluated in few studies. Palmqvist and Swartz[1] concluded that 92% of single crowns were still in place after 18 to 23 years. The reason for the removal of single crowns during the follow-up time remained unknown. Walton[2] found that the success of the single crowns was 75% after 5 to 10 years' service. Single crowns on nonvital teeth had a significantly greater failure rate than those on vital teeth. The most common reasons for intervention were root fractures (32%), coronoradicural fractures (24%), loss of retention (16%), and periodontal reasons (16%). Goodacre et al[3] evaluated the incidence of complications associated with single crowns (all-metal, metal-ceramic, or resin-veneered metal crowns). The length of the follow-up in the studies ranged from 1 to 23 years. The most common complications concerning single crowns were the need for endodontic treatment (mean incidence: 3%), porcelain fracture (mean incidence: 3%), and loss of retention (mean incidence: 2%). Periodontal disease and caries were rare complications (mean incidences: 0.6% and 0.4%, respectively). Näpänkangas et al[4] reported that after 10 years, 3 single metal-ceramic crowns out of 41 crowns (7%) were recemented, but none of the crowns were lost entirely.

The aim of this clinical retrospective study was to evaluate the survival and success of single metal-ceramic crowns after 20 years. The biologic and technical complications as well as patient satisfaction were recorded.

Materials and Methods

A total of 102 patients were treated with single metal-ceramic crowns between 1984 and 1987 by dental students at the Institute of Dentistry, University of Oulu,

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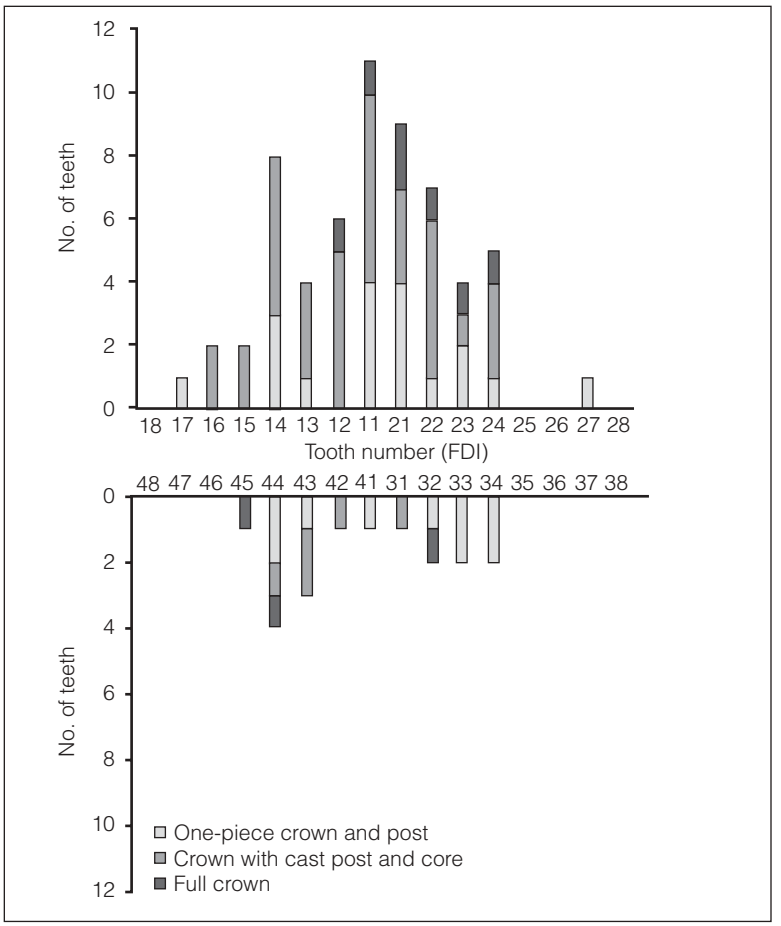

Fig 1 Distribution of the metal-ceramic single crowns.

Finland. All patients were sent an invitation for the clinical examination, and 50 patients (49%) attended the study. There were 34 women and 16 men; the mean age was 59.6 years (43 to 91 years). The mean follow-up time was 18.8 years (17.5 to 20.5 years). A total of 100 teeth were prepared for single metal-ceramic crowns. Patients had a mean of 2.3 crowns (1 to 9 crowns) each. There were 28 full crowns, 40 full crowns with a cast post and core, and 11 one-piece post crowns (Fig 1). Twenty-one single crowns were extracted (Fig 2). Root canal therapy was performed in 39 teeth prior to the prosthetic treatment. In 22 teeth (56%), there was no previous root canal therapy, and in 17 teeth, retreatment was performed (44%). None of these teeth had a previous prosthetic crown.

All follow-up examinations were carried out by the same clinician (RN) specialized in prosthetic dentistry and stomatognathic physiology. Anamnesis was taken after the initial prosthetic treatment, and patient opinions about esthetics, pain, sensitivity to cold or heat, root sensitivity, and gingival bleeding related to the single crowns were recorded. During the clinical examination, the periodontal condition (bleeding on probing and periodontal pockets), location of the crown margins with respect to to the gingival margins, and caries or restorations in the crown margin were evaluated. The crown margin excess, marginal fidelity (border between the crown and the tooth is felt with the probe), wear of both crowns and opposite teeth, deterioration of the border between porcelain and metal, and porcelain fractures were examined and estimated as acceptable or unacceptable. Evaluation of the teeth with crowns was performed using intraoral radiographs, and periapical pathology, the quality of root filling, length of the post, and root resection were examined. The dental treatment during the prosthetic treatment and the possible treatment performed after the initial treatment at the Institute of Dentistry was checked from the patient files.

The longevity of the single metal-ceramic crowns was counted from the day the crown was cemented to the day of complication, or if no complications occurred, to the day of the clinical examination. Kaplan-Meier survival analysis was performed on the basis of these facts. Success of the single crowns was defined as a crown that had remained unchanged over the observation period (according to Tan et al[5]). Survival of the single crowns was defined as a crown that was in situ at the examination visit irrespective of its recementation or porcelain fractures (according to Tan et al[5]).

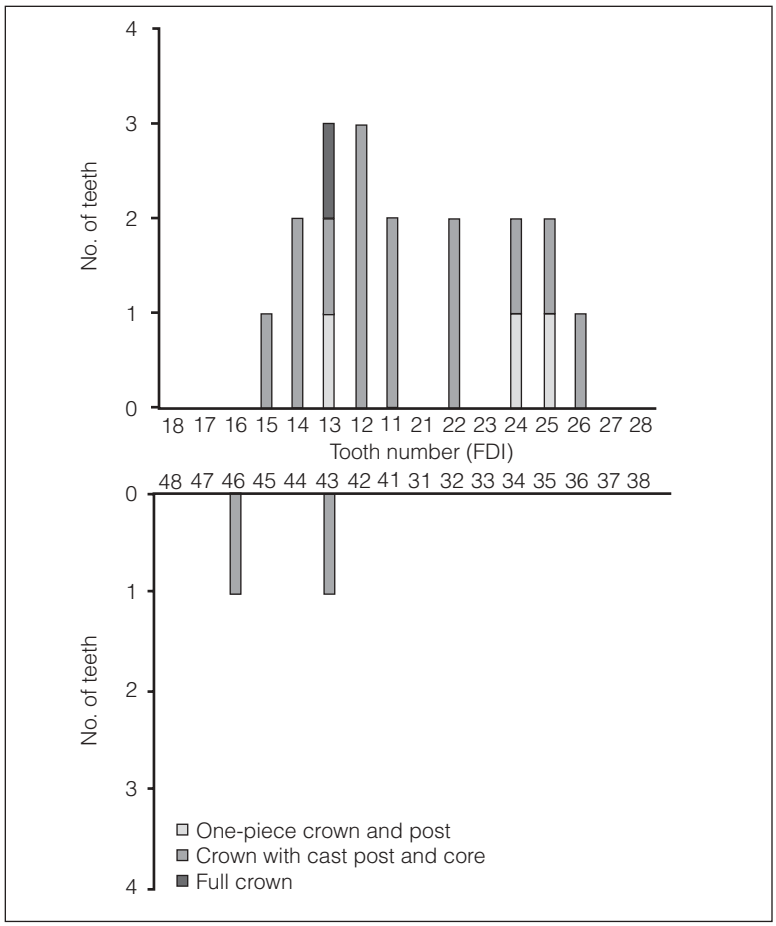

Fig 2 Distribution of the extracted teeth with crowns.

Results

Twenty-one teeth with single crowns were extracted (Fig 2). The reasons for the loss of crowns were root fractures (17 crowns, 81%), esthetic reasons (3 crowns, 14%), and periodontal reasons (1 crown, 5%). Concerning the teeth with root fractures, in 4 cases the root canal therapy was performed prior to the crown placement, and in 8 cases retreatment was performed.

Ninety-seven percent of the subjects had no complaints about the esthetics of the crowns. Some subjects had felt pain (11%), sensitivity to cold (11%), sensitivity to heat (4%), root sensitivity (13%), and gingival bleeding (21%).

Gingival bleeding on probing was found in 25% of the crowns and periodontal pockets (4 to 6 mm) in 17% of the crowns (Table 1). Excess in crown margins was found in 14% of the cases. The buccal crown margin was supragingival in 52% of the crowns, and palatal crown margin was supragingival in 29%. Caries lesions were found in 4% of the crowns (Table 2). Marginal fidelity was not satisfactory in 14% of the crowns (Table 3). Visible wear was scarce in the crowns (4%), but wear was found on the opposing teeth in 34% cases. All crowns were tightly cemented and immobile.

Table 1 Periodontal Findings After 20 Years of Follow-up

	No.	%
Bleeding on probing	20	25
Periodontal pockets (4–6 mm)	13	17
Crown margin excess	11	14
Buccal crown margin		
Supragingival	41	52
Marginal	36	45
Subgingival	2	3
Palatal crown margin		
Supragingival	23	29
Marginal	53	67
Subgingival	2	3

Table 2 Cariologic Findings After 20 Years of Follow-up

	No.	%
No caries	73	92
Caries lesion	3	4
Restoration in the crown margin	3	4
Total	79	100

Table 3 Technical Problems After 20 Years of Follow-up

	No.	%
Poor marginal fidelity	11	14
Occlusal wear		
Crowns	3	4
Opposite tooth	27	34
Wear between porcelain and metal	1	1
Porcelain fracture	2	3

Table 4 Length of the Post in Metal-Ceramic Single Crowns

Length	No.	%
Two thirds of root length	20	40
Half of root length	14	28
< half of root length	11	22
Prefabricated post	1	2
No post	4	8
Total	50	100

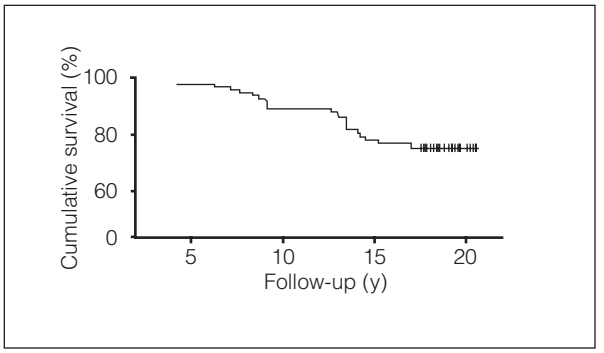

Fig 3 Success of the single metal-ceramic crowns after 20 years of follow-up.

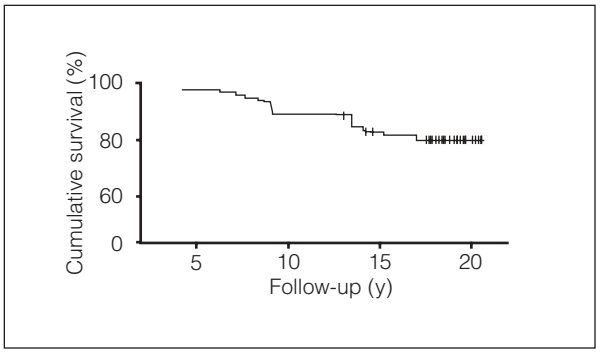

Fig 4 Survival of the single metal-ceramic crowns after 20 years of follow-up.

Radiologic examination was performed in 95% of the teeth with crowns; 2 patients refused examination (5% of the crowns). Periapical pathology was found in 11% of the teeth with crowns. Root resection was performed in 16 teeth (20%). In 1 tooth, the root resection was performed before the prosthetic treatment. The root canal treatment was faultless (root canal filling within 2 mm from the apex) in 64% of cases, and short (exceeding more than 2 mm from the apex) in 9%. In 39% of the crowns with posts, the length of the post was two thirds the root length, and in 28% of the crowns, the length of the post was half of the root length (Table 4).

The success of the single metal-ceramic crowns after 20 years was 75% (95% confidence interval: 66%–83%) (Fig 3) and the survival was 78% (95% confidence interval: 70%–86%) (Fig 4).

Discussion

The survival and success of single metal-ceramic crowns have rarely been evaluated,[1–3] and gold-acrylic crowns have also been included in the study groups. In this study, the success of metal-ceramic single crowns after 20 years was 75% and the survival was 78%. The results are in the same range as in the other studies. Walton[2] reported the success of the single crowns to be 75% after 5 to 10 years of service, and in the study of Palmqvist and Swartz,[1] the survival of single crowns was 92% after 18 to 23 years. Single crowns on nonvital teeth had a significantly greater failure rate than those on vital teeth.[2] Näpänkangas et al[6] evaluated the survival of single crowns with a dowel based on previous restoration of the tooth. It was found that after 72 months, the survival was 87% for 1-piece post crowns and 84% for composite resins with screw posts as a previous restoration.

Although follow-ups as long as 25 years have been conducted in other countries, no such study is available in Finland. The scarcity of follow-up studies can be assumed to be related to difficulties in gathering of the material. The data available concerning the dental treatment of patients in the health-care centers and private practices are restricted not only by difficulties in obtaining suitable data, but also by the incoherence in records and notes. At the Institute of Dentistry, patient records are recorded in a standardized fashion, and the treatment plans and treatment phases are similar between patients, providing extensive material to be evaluated.

This clinical 20-year follow-up examination is an extension of the 10-year follow-up examination performed in 1994.[4] In this study, there were more patients attending the follow-up because the time period was extended by 1 year (1984 to 1987 instead of 1984 to

1986) to get an adequate study group. The long follow-up period had an effect on participation in the study: many patients moved out of the region, could not be reached, or died. One reason for not attending the study could be loss of the crowns, and this could have changed the results.

Patients were satisfied with the single crowns; only a few patients had technical or biologic complaints. In most of the metal-ceramic crowns, the esthetics, color, and gloss of the crowns were acceptable, while in the studies on gold-acrylic fixed prostheses, failures as a result of appearance, wear, or deterioration of the acrylic veneers are common.[1,7]

The periodontal condition of the teeth with single crowns was generally good. Although gingival bleeding on probing and 4- to 6-mm periodontal pockets were found, only 1 crown was lost for periodontal reasons, and periodontal condition did not constitute a risk for loss of any crown in this examination. For the patients, the supragingival margins of the crowns were more important esthetically. The buccal crown margin was supragingival in 52% of the single crowns. Gingival recessions are common, but in the case of a metal-ceramic crown the root of the tooth is visible beside the margin of the crown, and this could lead to crown replacement for esthetic reasons. However, 97% of the patients mentioned no complaints about the esthetics of the crowns, and only 3 crowns were replaced for esthetic reasons.

Most of the single crowns were in the anterior maxilla (Fig 1). This could be assumed to be related to esthetic reasons. The same kind of crown distribution was also found in the studies of Eckerbom et al[8] and Fyffe.[9] Crown extractions were also more frequent in the anterior maxilla, although the failure distribution was quite even in the dentition (Fig 2). The reasons for crown removals were root fractures, esthetic reasons, and periodontal reasons. These reasons are also common in other studies.[2,3] In the present study, 2 single crowns were recemented. In the 10-year follow-up study,[4] 19% of the single crowns were recemented, and none of the crowns was lost. In the long run, it could be assumed that loss of retention could be a mark of root fracture, which results in extraction of the tooth.

The most important factor of preparation design in preventing root fractures has been shown to be the ferrule effect.[10] If ferrule is not achieved, the preparation should be extended more subgingivally, or a surgical crown lengthening or orthodontic extrusion may be needed.[11] The length of the endodontic post also affects root fractures in the same way as retention of single crowns. In mechanical studies, the optimal length of the post has been shown to be at least equal to the length of the root or, even better, two thirds the length of the root.[12–14] When tooth groups are considered, maxillary lateral incisors and first premolars seem to be most prone to root fractures.[6] These teeth are anatomically complicated by developmental invaginations and depressions of the tooth material and because the canal anatomy is often oval or ribbon-shaped. In restoration of these anatomically weak teeth, the preservation of the tooth structure is important, which should be kept in mind from the early stages of restorative treatment.

Conclusions

In the 20-year follow-up examination of single metal-ceramic crowns, the success was 75% and the survival was 78%. There were few biologic and technical complications found in the clinical examination, and patients were satisfied with the crowns. The removal of crowns was in most cases the result of root fractures in single crowns with posts.

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