A 2-year clinical evaluation of Sculpture crowns

Chul-Whoi Ku, DDS, MSD, Hong-So Yang, DDS, PhD
Resident, Department of Prosthodontics, College of Dentistry, Chonnam National University, Kwang-Ju, Korea
Professor and Chairman, Department of Prosthodontics, College of Dentistry, Chonnam National University, Kwang-Ju, Korea

Statement of problems. There are only a few studies available that deal with the clinical behavior of ceromer systems as potential substitutes for metal-ceramic crowns.
Purpose. This prospective study was initiated to evaluate the clinical performance of 35 Sculpture crowns after 2 years in service.
Material and methods. Thirty five Sculpture crowns were placed for 20 patients (7 men and 13 women). All patients were treated by the same dentist, and all restorations were fabricated by the same dental laboratory. Crown placement involved both the anterior and posterior regions of the dental arches. Patients were evaluated by two examiner at baseline, 12, and 24 months using the CDA quality assessment system in addition to periodontal criteria.
Results. Of 34 crowns remaining in the study after 2 years, only one crown had experienced a marginal fracture. The crown was replaced as a result of recurrent caries. All remaining crowns were ranked as either excellent or acceptable for surface and color, anatomic form, and marginal integrity.
Conclusion. The 2-year clinical observations and ranking with the CDA quality assessment criteria supported the conclusion that Sculpture crowns may be used in substitutes for metal-ceramic crowns.

Key Words :
Sculpture crown, CDA quality assessment, periodontal criteria

In today¡Ídentistry, the esthetic appearance of a restoration, as well as its functionability, is extremely important. This is particulary true in anterior locations, where restorations that are the same color as natural teeth are in great demand. To achieve this, ceramics and resins are often used as dental materials to reproduce natural tooth color.

The metal-ceramic crown is currently the most popular complete veneer restoration in dentistry because it derives its esthetics from the natural appearance of porcelain and its strength from a metal substructure. The lack of natural translucency associated with metal-ceramic crowns, however, has provided the impetus for the developing metal-free restorations. Composite resin, which

has been used for the facing on crowns, is not suitable for use on the jacket crowns in fixed partial dentures because of its low mechanical strength and poor wear resistance, in spite of its good workability.

Demand for more esthetically pleasing dental restorations and public fears about adverse side-effects of dental metals and alloys have led to the increased use of all-ceramic restorations. Moreover, new luting techniques have extended the indications for adhesive all-ceramic restorations. Recently, a variety of ceromer system with high mechanical strength and wear resistance equal to that of ceramics have also become available for clinical application.[1,2] The ultimate aim of such a system is to provide crowns with sufficient mechanical strength to resist occlusal forces while maintaining excellent esthetics and biological properties. Building upon the clinical success of dentin adhesion systems,[3,4] wear and abrasion evaluations,[5,6] and data on the strength of fiber reinforcement,[7,8] ceromer systems have become a viable treatment option for fixed partial dentures. However, clinical trial data supporting the efficacy of Sculpture crowns has not been reported.

The purpose of this study was to evaluate the clinical performance of the Sculpture crown during a 2-year test period.

MATERIAL AND METHODS

Twenty patients, 7 men and 13 women, were included in the study. All were receiving dental care within Chonnam national university hospital in Kwangju, Korea. The mean age of the patients was 46.1 years (range from 17 to 64 years). All patients requiring crown therapy for esthetic reasons were offered Sculpture crowns. The patients were informed of the research protocol and approved the need for periodic examinations. The study included all patients requiring such treatment from April 1998 to August 1998. Treatment plans for the 20 patients that involved both maxilla and the mandible and the anterior and posterior segments of the dental arches resulted in a total of 35 crowns. The distribution of restored teeth is presented in Table I.

Table I. Distribution of 35 cemented crowns

	Maxilla	Mandible	Total number
Incisors	9		9
Canines	1		1
Premolars	5	8	13
Molars	3	9	12
Total	18	17	35

All patients were treated by the same dentist during routine care, and all crowns were fabricated by the same dental laboratory. The tooth preparations consisted of moderate or deep chamfer with rounded, smooth contours and a lack of sharp line angles. Marginal reduction depths of 0.8 to 1.0 mm were used. Axial reduction of approximately 1.2 mm were achieved. Incisal or occlusal reduction of 1.5 to 2.0 mm were used. Once the tooth preparation was completed, routine dental techniques were used in taking the impression and pouring of the master cast.

When the master cast of the arch containing the prepared tooth and the cast of the opposing dentition had been articulated, the die was removed from its cast. A thin layer (<0.1 mm) of baseplate wax was applied as a blockout material, as well as a die spacer. The Sculpture (Jeneric Pentron, Connecticut, USA) ceromer material was used according to the manufacturer's guidelines. The coping was made on the die using a thin layer of opacious dentin paste corresponding with the shade indicated on the shade diagram. The coping was made 1 mm short of the margins, then cured in the Cure-Lite Plus (Jeneric Pentron, Connecticut, USA) light-curing oven for 2 minutes. Using a rope-like bead of the body paste in the shade indicated by the shade chart, the margin was

Table Ⅱ. Criteria for the CDA rating

Category	Score: Satisfactory	Score: Note acceptabl	Criteria
Margin integrity	Excellent		No visible evidence of a crevice along margin into which explorer will penetrate. No evidence of ditching along the margin.
	SCR		Visible evidence of slight marginal discrepancy with no evidence of decay; repair can be made or is unnecessary. The explorer gets stuck in one direction.
	SDIS		Discoloration on the margin between the restoration and tooth structure.
		TFAM	Faulty margins that cannot be properly repaired.
		TPEN	Penetrating discoloration along the margin of the restoration in pulpal direction.
		TCEM	Retained excess cement.
		VMO	Mobile restoration, or
		VFR	Fractured restoration, or
		VCAR	Caries continuous with margin of restoration, or
		VTF	Tooth structure fractured.
Anatomic form	Excellent		Restoration contour is in functional harmony with adjacent teeth and soft tissues within good individual anatomic form.
	SOCO		Restoration is slightly overcontoured, or
	SUCO		Restoration is slightly undercontoured, or
	SOH		Occlusion is not totally functional, or
	SMR		Marginal ridges slightly undercontoured, or
	SCO		Contact slightly open, or
	SFA		Facial flatting is present, or
	SLG		Lingual flatting is present.
		TUCO	Restoration is grossly undercontoured, or
		TOCO	Restoration is grossly overcontoured, or
		TET	Occlusion is affected, or
		TOC	Contact is faculty, or
		TOV	There is marginal overhang.
		VTO	Traumatic occlusion, or
		VUO	Gross underocclusion, or
		VPN	Restoration causes unremitting pain in tooth or adjacent tissue, or
		VDM	Damage is now occurring to tooth, soft tissue, or supporting bone.
Color and Surface	Excellent		There is no mismatch in color shade and/or translucency between the restoration(s) and adjacent teeth.
	Excellent		The surface of the restoration(s) is smooth. No irritation of adjacent tissue occurring.
	SMM		Slight mismatch between shade of restoration(s) and adjacent tooth or teeth.
	SRO		Surface of restoration is slightly rough; can be polished.
		TGI	Surface grossly irregular not related to anatomy and not subject to correction.
		TMM	Mismatch between restoration(s) and adjacent tooth or teeth outside the normal range of color, shade, and/or translucency.
		VSF	Surface is fractured, or
		VGP	There are gross porosities in the crown material.
		VSD	Shade in gross disharmony with adjacent teeth.

then sealed. The coping was veneered with the body paste to form the surface anatomy of the tooth. After the build-up process was completed, the crown was then cured for 9 minutes in the Cure-Lite Plus oven. White rubber wheels and a flame diamond were used to achieve the final textures and contours. The crown was sandblasted with 50-micron aluminum oxide powder inside and out at low pressure (20 psi) to ensure the integrity of the margin. The polishing was done using the polishing compound supplied in the Sculpture kit and a soft No. 11 Robinson brush.

Thirty-five crowns were cemented with resin cement (Panavia 21, Kuraray co., Osaka, Japan). Occlusion was adjusted as needed after cementation, and any reshaped surfaces were polished.

A clinical evaluation of the Sculpture crowns was performed using the California Dental Association (CDA) quality evaluation system (Table Ⅱ).[9]

Two evaluators examined the crowns for margin integrity, anatomic form, surface and color. Final evaluation of each crown was determined by the lowest value chosen for the 3 clinical characteristics evaluated. The evaluators were calibrated in the use of this evaluation system and worked as a pair but independently. A brief summary of the CDA rating system used is presented in table II. Whenever there was disagreement in the rating of a given restoration, the pair of examiners resolved their disagreement by joint examination.

In addition, occurrence of plaque and bleeding on probing in connection with the ceramic restorations and of the corresponding surfaces of the control teeth were recorded by one of the examiners. Plaque and bleeding indices used were in accordance with Silness and Loe.[10,11] Corresponding surfaces of the homologous tooth were used as control surfaces for evaluation of plaque and bleeding on probing. When the homologous tooth was lost or fitted with a Sculpture crown, the adjacent tooth or adjacent tooth to the homologous tooth was used as a reference. Data were collected at cementation (baseline), and every year after the baseline appointment for the period of 2 years for all 35 crowns.

RESULTS

The results of the CDA evaluation are presented in Tables III through VI. One crown was lost to recall during the 2-year study. At the 1-year appointment, 1 patient with 1 crown (1 premolar) had moved and was not available for examination during the remainder of the study. Therefore 34 Sculpture crowns were to recall during the 2-year study.

Only one crown (1 molar) had experienced a failure during the 2-year study. The crown was replaced in the first year because of marginal fracture and recurrent decay. The 33 crowns that remained in the study after 2 years had clearly demonstrated that they could withstand the forces generated during chewing and parafunctional activities without any signs of failure for the 3 factors considered. The percentage failure by location in the mouth was molars 8.4 %, premolars, canines and incisors 0 %.

The results of the CDA evaluation for the factor of surface and color are presented in Table Ⅲ. At the baseline appointment, all 35 crowns were rated as satisfactory, with 15 crowns rated as excellent and 20 crowns judged acceptable. At the 2-year examination, 10 crowns were rated as excellent, whereas 23 crowns were judged acceptable for surface and color. One of the 34 crowns that remained in the study after 2 years had been replaced for marginal fracture and recurrent decay.

The results of the CDA evaluation for anatomic form are presented in Table Ⅳ. At the baseline appointment, 19 crowns were rated as excellent and 16 crowns were judged acceptable for anatomic form. At the 2-year examination, 14 crown were rated as excellent and 19 crowns were rated as acceptable for anatomic form.

Table Ⅲ. CDA rating for surface and color of 35 crowns

Age	Satisfactory		Not acceptable
(month)	Excellent	Acceptable	Replace or correct
0	15	20	
12	12	21	1
24	10	23	1

Table Ⅳ. CDA rating for anatomic form of 35 crowns

Age	Satisfactory		Not acceptable
(month)	Excellent	Acceptable	Replace or correct
0	19	16	
12	15	18	1
24	14	19	1

Table Ⅴ. CDA rating for marginal integrity of 35 crowns

Age	Satisfactory		Not acceptable
(month)	Excellent	Acceptable	Replace or correct
0	27	8	
12	23	10	1
24	19	14	1

Table Ⅵ. Final CDA rating of 35 crowns

Age	Satisfactory		Not acceptable
(month)	Excellent	Acceptable	Replace or correct
0	12	23	
12	9	24	1
24	7	26	1

Table Ⅶ. Mean Plaque index values of 35 crowns

Age(moth)	Sculpture crowns	Control teeth
0	1.2	1.3
12	1.4	1.5
24	1.5	1.4

Table Ⅷ. Mean Bleeding on probing index values of 35 crowns

Age(moth)	Sculpture crowns	Control teeth
0	1.4	1.2
12	1.3	1.4
24	1.4	1.3

The results of the CDA evaluation for margin integrity are presented in Table Ⅴ. At the baseline appointment, 27 crowns were rated as excellent and 8 crowns were judged acceptable for margin integrity. At the 2-year examination, 19 crown were rated as excellent and 14 crowns were rated as acceptable for margin integrity.

The final rating of each crown was determined by the lowest CDA evaluation for the 3 clinical characteristics evaluated. The results for the final rating of each crown are presented in Table Ⅵ. At the baseline appointment, 12 crowns were rated as excellent and 23 crowns were acceptable. At the 2-year examination, 7 crowns were rated as excellent and 26 crowns were judged as acceptable, 1 crown had been replaced, and 1 crown was unavailable for evaluation.

Initial interexaminer agreement was 97.5% and after discussion of the disagreements, 100%. Disagreements occurred mainly in connection with the rating of color or of marginal integrity. Disagreements over marginal integrity consisted in uncertainties about whether the margin should be rated SCR or excellent.

The mean value of plaque and bleeding on probing index was calculated on the basis of 35 crowns and 35 controls. At the 2-year examination, the mean value of plaque index was 1.5 for Sculpture crowns and 1.4 for control teeth (Table Ⅶ). Corresponding figures for bleeding on probing were 1.4 and 1.3, respectively (Table Ⅷ). There was no significant difference regarding

plaque or bleeding on probing between teeth with Sculpture crowns and control teeth.

DISCUSSION

Many ceromer materials and systems are now available in the marketplace. Their use in the esthetic zone challenges both the functional and esthetic requirements of these systems. The properties of ceromer offer many advantages compared to composite resin or ceramics. The wear is very close to that of natural teeth.[12] Improved color stability over conventional composites is due to reduced water sorption. In addition, the moduli of elasticity are quite similar to that of dentin. These materials can be bonded to enamel and dentin for excellent retention and seal. They have various esthetic capabilities, and can be used without metal. They are also more easily repaired intraorally than ceramics. From a laboratory perspective, fabrication can be done directly on working dies, and shrinkage is minimal (<2 %) compared to ceramics. In addition, both the training involved and the learning curve are significantly reduced.[13-17]

The product in this ceromer system have improved properties over previous BisGMA, urethane, or polycarbonate-based resin composites due to advances in matrix chemical bonding. The indirect fabrication techniques allow for treatments (ie, heat, pressure, vacuum, inert gas, extended-duration light) that optimize polymerization and cross linkage.[18] The filler materials are also highly ratioed (>75 % by weight) and bind to the matrix more completely. During the treatment process, these products become a chemically bonded "fusion" of matrix and fillers. In addition to the term "ceromer", some other terms used to describe these products include "polymerceramic", "ceramic optimized polymer", and "polymer glass ceramic".[15]

A large number of clinical studies dealing with ceramic system was introduced. But there were few reports on the clinical study of this ceromer system. Clinical observations over 4-year periods have shown that this restorations had equal longevity to ceramic restoration.[19] Krejci reported that SEM revealed excellent margin after 1 year.[20] In other reports, examination after an average of 55.3 months revealed a 100% retention rate without fracture.[21] Therefore the purpose of this study was to evaluate the clinical performance of the Sculpture crown during a 2-year test period.

All patients treated with Sculpture crowns from April 1998 to August 1998 at a Chonnam National University hospital were included in this study. The observation period was short, and the intention was to follow the patient continuously. All step from preparation to luted crown were carried out by the same dentist for all the Sculpture crowns evaluated. Of course, this may have influenced the results and has to be taken into consideration when interpreting the outcome.

In a previous several study dealing with all-ceramic crowns,[22-24] all-ceramic crowns luted with a resin composite showed better resistance to fracture than crowns luted with other conventional cements. Though there is few study of the effect of the cement on Sculpture crowns, resin composite cements have been recommended to achieve adhesive bonding of Sculpture crowns. In this study, all crowns were cemented with a resin cement (Panavia 21, Kuraray co., Osaka, Japan).

A large number of the crowns were rated SOCO (restoration slightly overcontoured) because of overextention just above the cervical margin of the crowns. The gingiva of the teeth provided with those crowns were often slightly edematous. Regarding surface, 69 % of the crowns had a slightly rough surface. This was mainly seen on the occlusal surfaces of the molars, or premolars, and on the incisal or lingual surfaces of the incisors, whereas the rest of the restoration was rated excellent with regard to surface. That is, areas subjected to occlusal loading seemed to have been worn, causing a slightly rough surface.

For crown fractures, the failure rate in our study was 3 % of the 34 Sculpture crowns, 8.4 % for molars, 0 % for premolars, incisors and canines. Because there were few clinical studies dealing with Sculpture crowns, a comparison with some other crown systems was of interest. In a study of 100 Procera AllCeram crowns, the failure rate was 7.3 % for molars, 3.6 % for premolars, and 0% for incisors/canines, after 5 years of clinical service.[25] McLean[26] reported that corresponding figures for bonded platinum aluminous ceramic crowns, after 7 years in service, were 15.2 %, 6.4 % and 2 % for molars, premolars and incisor/canines, respectively. Scotti[27] in a study that involved 63 In-Ceram crowns reported a success rate of 98.4 % for the period of 24 to 44 months. Though the Procera AllCeram crowns,[25] the bonded platinum aluminous ceramic crowns[26] and In-Ceram crowns[27] represent different systems, the results of our study indicate that the Sculpture crowns can be an alternatives of the all-ceramic crowns.

There was no significant difference with regard to plaque or bleeding on probing in connection with the surfaces of the Sculpture crowns compared to the control surfaces. The slight overextension observed just above the cervical margin of the Sculpture crowns may contribute to increased plaque and bleeding on probing in connection with the Sculpture crowns registered in our study. It is also possible that the surface porosity of Sculpture crowns may contribute to increased plaque and bleeding on probing. In addition, it has to be taken into consideration that the condition of the surface of the crowns may have changed with time.

The small number of crowns investigated in this study limits any conclusions from the results. Long-term follow-up of cases such as the one presented are needed to adequately compare to previous materials and techniques for fixed partial dentures. Further long-term studies with a larger number of crowns are necessary to support this indication.

CONCLUSIONS

Thirty five Sculpture crowns were fabricated and cemented on 12 molars, 13 premolars, and 10 incisors/canines in 20 patients and evaluated using the CDA criteria and periodontal factors during a 2-year test period. Within the limits of this study, the following conclusions were drawn.

1. Of the 34 Sculpture crowns followed during a 2-year clinical trial, 1 crown (3 %) experienced fracture of crown margin and the crown was replaced because of recurrent decay.
2. Ninety-seven percent of the crowns rated either excellent or acceptable by the CDA quality assessment criteria after 2-year clinical trial.
3. The failure rates was 8.4 %, in molar area and 0 %, in other areas.
4. There was no significant difference regarding plaque or bleeding on probing between teeth with Sculpture crowns and control teeth.

CLINICAL IMPLICATION

The clinical performance of Sculpture crowns in service for 2 years demonstrated that 33 of the 34 crowns (97 %) were rated either excellent or acceptable by the California Dental Association quality assessment criteria. These results indicate that the Sculpture crown can be an option for substitute of the metal-ceramic crowns in carefully selected patients.

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Reprint request to:
DR. HONG-SO YANG
DEPT OF PROSTHODONTICS, COLLEGE OF DENTISTRY,
CHONNAM NATIONAL UNIVERSITY
HAK-DONG 8, DONG-KU KWANG-JU, 501-191 KOREA
E-mail: yhsdent@chonnam.ac.kr
Phone: +82-62-220-5462, Fax: +82-62-227-7426