A clinical evaluation of the Optec inlay system

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To evaluate the clinical quality of ceramic (Optec) inlays, the inlay production of 10 dentists, served by 3 dental laboratories, was examined independently by 2 calibrated examiners. A total of 57 patients with 205 inlays (mean age, 8.1 months) were examined 1 to 32 months after placement by means of using a slightly modified form of the California Dental Association criteria. Periodontal variables such as plaque index, gingival index, and margin index were also recorded. Eight patients reported postoperative but not persistent hypersensitivity in relation to the Optec therapy. No differences between Optec proximal surfaces and homologous control surfaces were seen with regard to plaque or bleeding on probing. The examination using the CDA criteria showed that 59% of the inlays had a slight color mismatch. Slightly roughened surfaces were most common (86%). As to anatomic form and margin integrity, 24% and 67%, respectively, of the inlays were rated excellent. A difference between the dentist with regard to the clinical quality of the inlay treatment procedure was seen. The present results cannot allow a definitive judgement with regard to the long-term clinical quality of the Optec inlay system but will serve as a base for further studies. □ *Ceramic inlays; clinical examination; porcelain*

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An increasing interest in and patient demand for tooth-colored, nonmetallic restorations during the past decade has resulted in the development of a great number of ceramic systems as an alternative to silver amalgam alloys in particular in posterior teeth. Ceramics are well known to be esthetic and biocompatible materials and should therefore be viable alternatives when applying the appropriate case selection and indications for their use clinically. However, many of the ceramic systems on the market, used for the inlay procedure, were originally meant for the full-crown technique, and their mechanical properties may therefore not be suitable for the inlay technique. These materials could be too fragile and nonresistant to fracture before being bonded to the tooth structure by an etching technique and also when exposed to functional loading. At present, there are several ceramic materials commercially available for the indirect or direct inlay procedure.

With regard to longevity, the interface between tooth structure and inlay will probably be of critical importance. A clinical consideration of significance is the mode of cementation and the type of cement used. Several in vitro studies have convincingly reported that the marginal fit of ceramic inlays is inferior to that of gold inlays (1–4). This marginal discrepancy is said to be compensated for by the use of a bonded dual-cure composite resin luting agent, filling the gap. In the long term, however, this could be a serious drawback, promoting the failure of the restoration due to dissolution and leakage, discoloration, and excessive wear of the luting agent. So far, clinical in vivo studies are too scarce and limited in time to verify these assumptions, particularly in the long term. Therefore, a need for longitudinal evaluations of this type of therapy seems to be essential to achieve a basis for its performance, and guidelines for clinical acceptability.

In consequence, this study was performed to evaluate clinically a high-strength porcelain system (Optec) used for the inlay procedure.

Materials and methods

Three dental laboratories in Sweden were questioned about their Optec inlay production. Thereby 10 dentists, 8 in Göteborg and 2 in Stockholm, were located and asked whether they would agree to having their patients with Optec inlays participate in a clinical evaluation. The dentists, of whom seven were private practitioners, two worked for the National Health Service, and one was a faculty staff member, all agreed to participate. As a result 57 patients with a total of 205 Optec inlays were examined. The mean and median age of the 39 female patients were 41.6 and 41 years, respectively (range, 19–72 years), and those of the 18 male patients 39.1 and 38.5 years, respectively (range, 15–62 years).

Apart from routine anamnestic records the patients were asked about the reasons for treatment with porcelain inlays. Complications during and after the placement were reported by each dentist, as were the subjective impressions of each patient. The status of the oral mucosa, the temporomandibular joint (TMJ), and the masticatory muscles and the incisal and occlusal tooth wear (5) were recorded. The margin index in accordance with Silness (6), and the plaque and bleeding index in accordance with Lenox & Kopczyk (7) were monitored. For comparison, the periodontal variables were recorded on surfaces restored with an inlay and, if available, on homologous surfaces not treated with an inlay. The restorative status of the homologous teeth was also recorded.

Information about cavity treatment and luting technique was obtained from patient records and/or from direct questioning of the dentists.

The clinical examination and evaluation were performed by the authors after a careful calibration procedure. The two authors examined all the restorations independently in accordance with a slightly modified form of the California Dental Association's (CDA) quality evaluation system (8). In case of disagreement, the result was discussed, and a joint decision was made. The CDA criteria focus on Surface and Color, Anatomic Form, and Margin Integrity, and each restoration is given a rating representing one of two main categories: satisfactory with the subratings excellent (R) and acceptable (S), and not acceptable with the subratings replace/correct (T) and replace immediately (V). For Color the subrating excellent (R) was modified to absolutely perfect (R0) and a small mismatch in color (R1).

Results

The number, median and mean age, and the age range of the Optec inlays as related to dentist and dental laboratory are presented in Table 1. One hundred and twenty inlays were placed in the molar and 85 in the pre-

Table 1. Number, median age, and age range of Optec inlays as related to dentist and dental laboratory

Dentist	Dental laboratory	No. of inlays (*n*)	Median age (months)	Mean age (months)	Range (months)
A	I	14	7	7.3	1–15
B	I	4	15.5	15.5	12–19
C	II	36	9.5	11.4	1–20
D	I	8	4	3.6	3–4
E	II	20	11.5	11.5	3–21
F	I	11	11	12.1	3–32
G	II	9	2	5.7	1–15
H	I	17	7	5.7	1–12
I	III	51	7	5.9	1–10
J	III	35	6	6.7	1–19
Total 10	3	205	8	8.1	1–32

Table 2. Distribution of restorations on available homologous teeth

Type of restoration	No. of proximal surfaces restored
Isosit inlay onlay	2
Hi-ceram	2
Gold	6
Acrylic	8
Temporary filling material	9
Composite	17
Metal ceramic	58
Amalgam	41
Total	143
Not restored	12
Total	155

molar region. Twelve inlays were of class-I and 193 inlays of class-II type of restoration. The number and type of restorations on available homologous teeth are presented in Table 2.

Eight dentists used a dentin bonding agent, while two dentists did not. All inlays were cemented with dual-cured light-activating composite resins. Three dentists (A, C, E) used a metal strip, and one dentist (J) a plastic strip during cementation, whereas the remaining dentists did not use a strip at all.

Twenty-three patients reported that esthetic reasons and 25 patients that aversion to metallic restorations in general and dental amalgam in particular was the reason for the replacement with porcelain inlays. Nine patients reported that they had been advised to choose Optec therapy by their dentist. Eight patients reported postoperative but not persistent hypersensitivity after treatment. However, one patient had two Optec inlays replaced by gold inlays owing to severe hypersensitivity. These inlays were not included in the study since they had been replaced at an early stage and had therefore not been examined.

The clinical examination showed that four patients had nickel allergy. Three patients had signs of lichenoid lesions of the buccal mucosa in relation to the Optec inlays. Four patients had clicking sensations from the TMJ bilaterally, and 19 patients showed moderate tenderness on palpation of the masticatory muscles. Forty-five patients showed moderate (II) to severe (III) wear of occlusal surfaces.

Most of the inlays had subgingivally placed margins (Table 3). No difference between Optec inlay surfaces and homologous surfaces were seen either for proximal plaque or for bleeding on probing (Tables 4 and 5). The examination using the modified criteria of the CDA with regard to Color showed an absolutely excellent rating (R0) in 6.8%. The excellent ratings were 14.1% for Surface, 23.9% for Anatomic Form, and 67.3% for Margin Integrity. The number and percentage of inlays not receiving an excellent CDA rating are presented in Table 6. A slight but detectable color mismatch (R1) between the inlay and the tooth structure was seen in 41.5%, and a more distinct mismatch (SMM) was seen in 51.7%. As to Anatomic Form the most frequent finding was slightly undercontoured marginal ridges (SMR) in 63.9% and slightly overcontoured restorations (SOCO) in 13.7%. Visible evidence of ditching along the margin (SCR) was seen in 23.4%. In four of the inlays (1.9%) restoration material was missing (VMIS), and three inlays (1.5%) were fractured (VFR).

Table 3. Margin index scores of Optec proximal surfaces

Surface	Score 0	Score 1	Score 2	Score 3
Mesial (n = 149)	4	16	26	103
Distal (n = 152)	15	6	27	104

Score 0 = restoration margin > 2 mm above the gingival margin; score 1 = restoration margin < 2 mm above the margin; score 2 = restoration of the gingival margin; and score 3 = restoration below the gingival margin.

Table 4. Relative number and percentage of restored proximal surfaces with plaque

	Optec surfaces (n = 301)		Homologous surfaces (n = 142)	
Surface	Relative no.	%	Relative no.	%
Mesial	131/149	87.9	73/73	100
Distal	139/152	91.4	53/69	76.8
Total	290/301	89.7	126/142	88.7

The percentage of Optec inlays not receiving an excellent CDA rating related to treating dentist is presented in Table 7. Differences in clinical quality of the Optec inlay treatment was seen between the dentists. The overall best result was produced by dentist F. No differences were seen between the dental laboratories with regard to the quality ratings.

The inter-examiner agreement of the CDA quality rating was 96%.

Discussion

The patient selection was based on the objective to examine all patients treated with Optec inlays by the participating dentists. However, the patient selection was made by the dentists without the authors' influence, other than the request to refer all patients treated. The fact that almost 70% of the patients in this study were women is well in agreement with other studies concerning tooth-colored restorations (9–11). This might reflect a greater interest in tooth rehabilitation that improves esthetics in women than in men. However, as 59% of the inlays were placed in the molar region, esthetics may not have been the main reason for the porcelain inlay therapy. This was also verified by the fact that 44% of the patients reported that they had chosen this type of therapy to avoid metallic restorations, compared with the 40% who had chosen it for esthetic reasons. That females are more negative to metallic restorations has been shown in several other studies (12–14) and is corroborated by our findings.

Sixteen per cent of the patients had been advised to have an Optec porcelain inlay restoration by their dentist. This is a low frequency compared with a similar study of Cerec inlays (10) in which almost 60% of the patients had been advised to choose Cerec therapy by their dentist. However, this discrepancy may be explained by the fact that a dentist who has access to a special type of equipment and who has learned a special technique, as for Cerec inlays, prefers this therapeutic method.

Postoperative hypersensitivity has been reported in several studies concerning tooth-colored inlays (9, 10, 15). Factors such as cavity treatment, luting medium, bacterial invasion, and pulpal inflammation have been presented as possible explanations of this phenomenon (16, 17). In the present study eight patients (14%) reported postoperative hypersensitivity after treatment. This is

Table 5. Relative number and percentage of restored proximal surfaces with bleeding

	Optec surfaces (n = 301)		Homologous surfaces (n = 142)	
Surface	Relative no.	%	Relative no.	%
Mesial	54/149	36.2	26/73	35.6
Distal	55/152	36.2	26/69	37.7
Total	109/301	36.2	52/142	36.6

Table 6. Number and percentage of Optec inlays ($n = 205$) that did not receive an excellent CDA rating*

	Surface	Color		Anatomic form							Margin integrity				
	SRO	R1	SMM	SMR	SOCO	SUCO	SOG	SCO	TCO	TPX	SCR	SDIS	TMD	VFR	VMIS
Percentage	85.9	41.5	51.7	63.9	13.7	4.4	2.0	3.4	0.5	0.5	23.4	7.3	1.0	1.5	1.9
n	176	85	106	131	28	9	4	7	1	1	48	15	2	3	4

* SRO = surface of restoration is slightly rough or pitted, can be polished; R1 = small mismatch in color, shade and/or translucency between restoration and adjacent tooth structure; SMM = mismatch between restoration and tooth structure within the normal range of tooth color, shade, and/or translucency; SMR = marginal ridges slightly undercontoured; SOCO = restoration is slightly overcontoured; SUCO = restoration is slightly undercontoured; SOG = occlusal contour not continuous with that of cusps and planes; SCO = contact slightly open (may be self-correcting); TCO = contact is faulty (self-correcting is unlikely); TPX = interproxial cervical area undercontoured, tissue damage likely; SCR = evidence of ditching along the margin, not extending the DE junction; SDIS = discoloration on the margin between the restoration and the tooth structure; TMD = dentin or base is exposed along the margin; VFR = restoration is fractured; VMIS = restoration is missing.

Table 7. Percentage distribution of Optec inlays which did not receive an excellent CDA rating* with regard to treating dentist

		Surface	Color		Anatomic form							Margin integrity				
Dentist	*n*	SRO	R1	SMM	SMR	SOCO	SUCO	SOG	SCO	TCO	TPX	SCR	SDIS	TMD	VFR	VMIS
A	14	42.8	78.6	21.4	14.3	28.6	7.1					71.4	14.3			
B	4	100	75.0		75.0								25.0	25.0		
C	36	91.6	52.8	27.8	44.4	11.1		5.6				8.3	2.8			
D	8	100	75.0		37.5		12.5	25.0				75.0				
E	20	85.0	50.0	40.0	85.0	10.0						30.0	5.0		5.0	
F	11		81.8	9.0		18.2	9.1					9.1				
G	9	100	44.4	44.4	100	44.4						11.1				
H	17	94.1	35.3	64.7	58.8					5.9	5.9	35.3		5.9	11.8	5.9
I	51	94.1	9.8	90.2	74.5	5.9	7.8		9.8			19.6	7.8			
J	35	100	34.3	65.7	94.3	25.7	5.7		5.7			14.3	17.1			

* The abbreviations of the ratings are explained in Table 6.

about the same frequency as reported for Cerec inlays (10). As the hypersensitivity was not persistent in any of the patients and as no systematic observations were connected with this symptom, it is possible that the cavity treatment of earlier decayed and filled teeth initiated the temporary hypersensitivity.

According to the manufacturer's instructions Optec restorations are contraindicated in patients with bruxism. It is noteworthy that about 80% of the patients had moderate to severe wear of the occlusal surfaces and that more than 30% of the patients showed signs from the craniomandibular system, indicating that bruxism had taken place. These findings do not seem to have any effect so far on the clinical performance of the Optec inlays studied here. However, it should be realized that the median age of the inlays was less than 1 year. To evaluate the longevity of this porcelain system, further studies are necessary.

Concerning plaque and bleeding on probing, there were no differences between the 301 inlay proximal surfaces and the 142 homologous surfaces not restored with Optec inlays (Tables 4 and 5). This is in accordance with the findings for Cerec inlays (10). It is predictable that the Cerec inlay system, in which the dentist has to give the ceramic surface the final polish, will not give as excellent a result as can be achieved by the dental laboratory procedure. The superior polishing grade achieved in this manner requires that any necessary adjustment to get an acceptable form is done before the final glazing. However, according to the quality rating with regard to the CDA criteria, the most notable deviation from excellence was related to the variable Surface. Apparently, the above-mentioned more time-consuming step was neglected, and the adjustments were not followed by a satisfactory polishing, which explains the rough surface. In this respect the Optec inlays were comparable to the Cerec inlays.

The results reported for Dicor inlays/crowns (9, 18, 19), in which more plaque was seen on homologous surfaces than on porcelain surfaces, has made us conclude that this type of restoration would possess some advantage with regard to the resistance to plaque accumulation. Results from a clinical study evaluating Dicor inlays (9) showed that only 13% of the inlays did not receive excellent ratings with regard to Surface, compared with 74% for Cerec inlays (10) and 85% in the present study. Altogether these results indicate that the surface texture is important for the plaque accumulation. However, as the bleeding on probing was not reflected by the plaque accumulation in any of the studies, a multifactorial explanation seems to be more pertinent. It might be speculated whether different material surface properties or individual patient factors prevail.

With regard to Color all the inlays were rated satisfactory, but only 48% within the range of excellence (R0/R1). This is about the same frequency as has been reported for Dicor inlays (9) but not as good as the results from a similar study of Cerec inlays (10). With regard to the Dicor inlays this deviation from the rating excellence was explained by the fact that the inlays had been adjusted, leaving a surface stripped of its colored glazing, exposing the opaque glass. This is probably a valid explanation for the Optec inlays as well, since in most cases they were extensively adjusted in the occlusal surface area affecting the coloring layers. Another but less feasible explanation might be poor shade matching by the dentist.

Compared with other studies, the Optec inlays had a significantly lower number of excellent ratings for anatomy. This is in line with the already discussed consequences of the extensive surface adjustment of the inlays. Nearly 70% of the inlays were rated excellent with regard to Margin Integrity. This has also been reported for Dicor inlays (9). In that study the deviation from excellence could be explained by a poor luting medium (zinc–phosphate cement) for that purpose. In the present study all the inlays were cemented with dual-cured light-activating resin cement. Considering the fact that the luting technique is clinically sensitive and that most of the margins were placed subgingivally (Table 3), the clinical outcome must be regarded as acceptable. Furthermore, the fact that this study in relation to

the Dicor study (9) comprised a substantially greater number of inlays made by more dentists indicates that the results were within the range of normal clinical variation. A higher frequency of excellent ratings reported for Cerec inlays (10) might be explained by different material properties. The prefabricated Cerec ceramic block obtains a high and uniform quality, making it less fragile than manually produced porcelain. It can therefore be handled more like a metallic restoration at the cementation procedure, and consequently a small marginal discrepancy can be achieved.

The difference in clinical quality between the participating dentists was not related to any specific CDA variable, the number of inlays, or their time in function. Nor could any systematic pattern related to dental laboratory procedures explain the quality deviation. The authors' impression is that the attitude towards excellence has to be even more pronounced in the case of ceramic inlay restorations than for conventional dental treatment procedures.

The results of the present clinical evaluation indicate that the clinical acceptance of the Optec porcelain inlay system is satisfactory in the short run and in agreement with the results from other similar studies. However, the material properties and clinical handling difficulties necessitate a more time-consuming clinical procedure than for metallic restorations to achieve the best clinical results. From a clinical point of view this is a limitation of the system but can be accepted if these preliminary promising results remain constant. However, further studies are necessary to establish this, and the present study should serve as a base.

References

1. Shortal AC, Baylis RL, Grundy JR. Marginal seal comparisons between resin-bonded class II porcelain inlays, posterior composite restorations, and direct composite resin inlays. Int J Prosthod 1989; 2:217–23.
2. Fett HP, Moermann WH, Lutz F, Krejci I. Margin adaptation of computer machined Cerec inlays in vitro. J Dent Res 1989;68(spec iss): 324, IADR abstr no 1141.
3. Hung SH, Hung K-S, Eick JD, Chapell RP. Marginal fit of porcelain-fused to metal and two types of ceramic crowns. J Prosthet Dent 1990;63:26–31.
4. Qualtrough AJE, Cramer A, Wilson NHF, Roulet J-F, Noack M. An in vitro evaluation of the marginal integrity of a porcelain inlay system. Int J Prosthod 1991;6:517–23.
5. Hugoson A, Bergendahl T, Ekfeldt A, Helkimo A. Prevalence and severity of incisal and occlusal tooth wear in an adult Swedish population. Acta Odontol Scand 1988;46:255–65.
6. Silness J. Periodontal conditions in patients treated with dental bridges. J Periodontol 1970;5:60–8.
7. Lenox JA, Kopczyk RA. A clinical system for scoring a patient's oral hygiene performance. J Am Dent Assoc 1973;86:849–52.
8. Quality evaluation for dental care. Guidelines for the assessment of clinical quality and professional performance. Los Angeles: California Dental Association, 1977.
9. Bessing C, Molin M. An in vivo study of glass ceramic (Dicor®) inlays. Preliminary report. Acta Odontol Scand 1990;48:351–7.
10. Sjögren G, Bergman M, Molin M, Bessing C. A clinical examination of ceramic (Cerec®) inlays. Acta Odontol Scand 1992;50:171–8.
11. Karlsson S, Landahl I, Stegersjö G, Milleding P. A clinical evaluation of ceramic laminate veneers. Int J Prosthod. In press.
12. Johansson B, Stenman E, Bergman M. Clinical study of patients referred for investigation regarding so-called oral galvanism. Scand J Dent Res 1984; 92:469–75.
13. Hugoson A. Results obtained from patients referred for investigations of complaints related to oral galvanism. Swed Dent J 1986;10:15–28.
14. Meurman JH, Porko C, Murtomaa H. Patients complaining about amalgam-related symptoms suffer more often from illnesses and chronic craniofacial pain than their controls. Scand J Dent Res 1990; 98:167–72.
15. Hickel R. Zur Problematik hypersensibler Zähne nach Eingliederung von Adhäsivinlays. Dtsch Zahnaerztl Z 1990;45:740–2.
16. Charbenau GT, Klausner LH, Brandau HE. Glass ionomer cements in dental practice: a national survey abstract. J Dent Res 1988;67(spec iss):283.
17. Biocompatibility and postoperative sensitivity. Council on Dental Materials, Instruments and Equipment. J Am Dent Assoc 1988;116:767–8.
18. Malament KA, Grossman DG. The cast glass-ceramic restoration. J Prosthet Dent 1987;57:674–83.
19. Savitt ED, Malament KA, Socransky SS, Melcer AJ, Backman KJ. Effects on colonization of oral microbiota by a cast glass-ceramic restoration. Int J Periodont Restor Dent 1987;2:23–35.

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