CEREC® CAD-CAM Ceramic Restorations
A Case Report after 5 Years in place

CEREC® CAD-CAM keramički inlay-i
Prikaz slučaja nakon 5 godina

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Abstract

At least three different techniques have been described for preparing computer-aided designed (CAD) and computer-aided manufactured (CAM) inlays and veneers. This paper details a clinical case in which 13 Cerec CAD-CAM inlays have been in function for five years. The Cerec® – System produces ceramic inlays which are designed, fabricated and placed during one appointment. Advantages and system-related limitations are discussed.

Key words: *ceramic restorations, case report.*

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Introduction

Initial work in the field of high-tech restorative dentistry began in the 1970's (1-3), but since the 1980's the »French«, »Minnesota« and »Cerec« systems have evolved and reviews of these three systems have recently been published (4-8). Presently, the Cerec system is the only commercially available CAD-CAM system which fabricates inlays, onlays and veneers.

Ceramics, in contrast to composite resins, more closely approximate the physical and chemical properties of enamel (9-15), and etched porcelain successfully bonds to etched enamel when a composite resin-based cement is used (16-19). Both acid-etched porcelain and Dicor glass ceramic inlays cemented to etched enamel using a composite resin-based cement have excellent marginal qualities (20-23). The cuspal fracture resistance of etched porcelain-restored teeth is equivalent to the cuspal fracture resistance of unprepared maxillary premolars (24).

At least two visits are required to fit conventionally fabricated porcelain and composite resin inlays. During these visits, impressions are taken, temporary restorations are placed, casts are made, and, after the firing and/or casting, the ceramic inlay is fitted. However, since September 1985 the Cerec-method has been used clinically eliminating the currently practiced impression, die, lost wax casting technique (7). The Cerec-system (computer reconstruction) was first presented to the dental profession in 1986 (25, 26), but has been repeatedly described since 1980 (27-30). The purpose of this paper is to describe the actual status of the Cerec-method and to present a case report on Cerec restorations after five years in place.

Material and methods

The »Optical impression«

The Cerec system (ceramic reconstruction) consists of a self-contained mobile unit with a

miniature three-dimension intra-oral video camera, a monitor, keyboard and a computer which controls the three axis diamond-coated milling device (Fig 1).

The dentist prepares an inlay/onlay type cavity. Using the camera the three-dimensional data of the cavity preparation are recorded instantaneously when the camera snaps the »optical impression«. The camera head containing the lens is positioned over the prepared, powder-coated cavity and stabilized, either by resting it against an adjacent tooth or by bimanual finger rest (Fig. 2). Cerec powder is air blown over the preparation to obtain opaque, non-reflective surfaces. The powder is inert and readily removed with a conventional water spray after the »optical impression« is taken. Figure 3 presents a flow diagram of the »optical impression« procedure. The video search mode enables assesment of whether the camera viewing axis is compatible with the inlay/onlay path of insertion. The dentist checks the cavity preparation and camera position displayed by the live image on the monitor. The cavity is detailed on the monitor by using the camera search mode while the three-dimensional camera is held by the dentist. If the preparation and the viewing axis both are acceptable, the three-dimensional scanning is triggered by release of the foot pedal. The scanning time is 0.3 seconds. The three-dimensional scanned preparation is seen as a static (freeze frame) image on the monitor. The dentist now checks and verifies the preparation and its three-dimensional representation for corrections to be made, if necessary. The optical technique enables rapid repetitions and optimizing of the cavity preparation and its three-dimensional representation. After the »optical impression« is accepted the dentist starts working on the design of the restoration.

Designing the Restoration

Additional data related to the restoration outlines are fed manually into the computer, producing the view on the monitor shown in Fig 4.

Figure 4 shows the pseudoplastic freeze frame image of an onlay cavity preparation representing the complete three-dimensional set of data recorded by the »optical impression«. The dentist now starts designing the onlay by tracing frame lines on the optical impression while it is displayed on the monitor. The first step is to define the preparation floor.

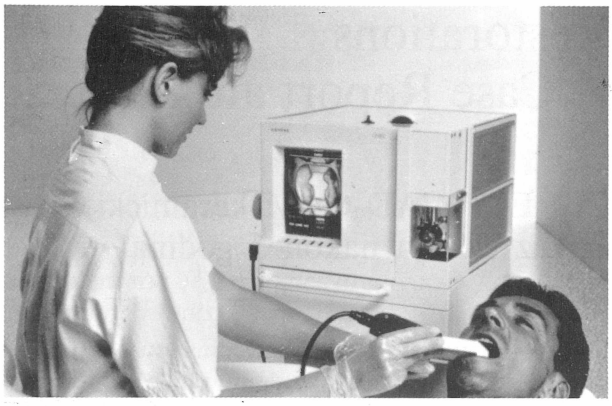

Fig. 1. *Three-dimensional intra-oral camera over an MOD cavity which is displayed on the mobile unit's video screen.*

Slika 1. *Trodimenzionalna intra-oralna kamera iznad MOD-kaviteta, koji je prikazan i na video-ekranu.*

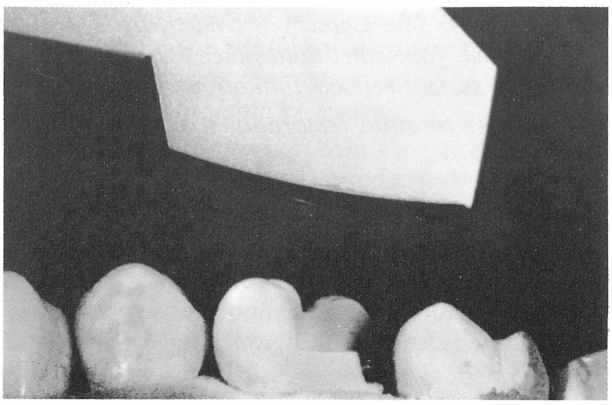

Fig. 2. *Camera is positioned over the onlay cavity preparation. Cerec powder is air blown over the preparation to obtain opaque non-reflective surfaces.*

Slika 2. *Kamera je postavljena iznad onlay-preparacije. Cerec prašak je nanesen preko preparacije, kako bi se stvorila zamućena, nereflektirajuća površina.*

A new Cerec operating system (31) interactively guides the dentist through the design process. Head- and footlines remind the operator of the next step offered by the system, e.g. »DRAW CAVITY FLOOR« (»BOTTOM«) shown in Figure 4. A list of 9 symbols (icons) at the left enable the dentist to activate the operating steps:

- Select the tooth to be restored
- Take optical impression
- Adjust three-dimensional data
- Proceed to next step (draw cavity floor, proximal contact lines)

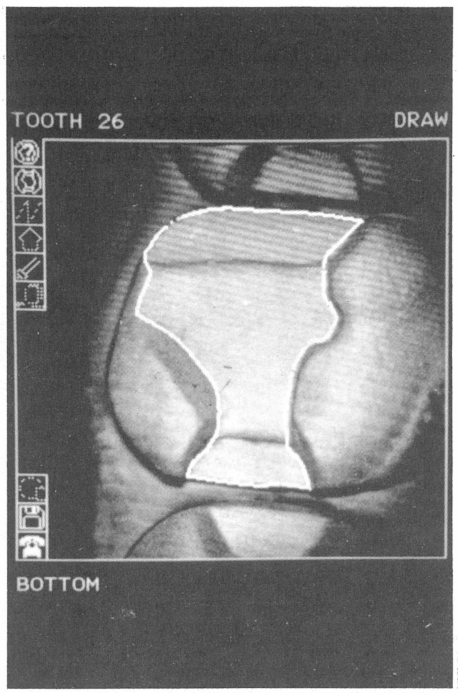

Fig. 3. *Three-dimensional appearance of an onlay cavity (Tooth 26; FDI number) showing the tracing lines of the cavity floor on the video screen.*

Slika 3. *Trodimenzionalni izgled onlay-kaviteta s obilježavajućim prugama na video-ekranu.*

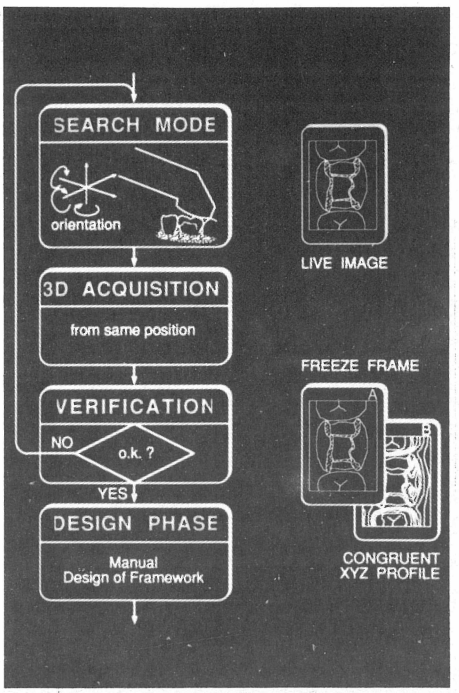

Fig. 4. *Flow diagram showing the specific Cerec »optical impression« method.*

Slika 4. *Dijagram koji pokazuje metodu Cerec optičkog otiska.*

- Editing individual lines
- Delete lines
- Save optical impression and lines on disk
- Complete full data-based design
- Start machining process
- Open service box

Dialog windows additionally keep the operator informed about the actual status of the system.

Grinding Process

All the stored data are subsequently used to direct the milling process which is carried out by a rotating diamond-coated disc (Fig 5). The inlay is milled from a homogenous, quality-controlled, factory-prepared standardised ceramic block (Fine porcelain, Vita; Dicor MGC, Dentsply) within four to seven minutes. The inlay and enamel margins are acid-etched and the restoration is cemented with a dual curing posterior composite (Figs 6 and 7). This paper describes a case where all the amalgam restorations were replaced by Cerec-inlays and onlays (8).

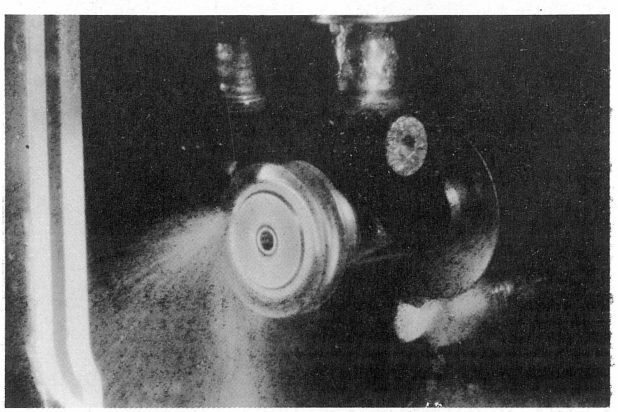

Fig. 5. *Milling of the ceramic block in the chamber seen in Fig. 1 on the unit's lower left.*

Slika 5. *Brušenje keramičkog bloka u komori koja se vidi na slici 1, u donjem lijevom dijelu uređaja.*

These restorations have been in place for five years.

Case Report

A 32-year-old female patient presented at the Department of Preventive Dentistry, Periodon-

tology and Cariology of the Zurich University in December 1985. She requested the replacement of all her amalgam restorations with natural tooth-colored material for esthetic reasons. Her general medical history was uneventful, and as her oral hygiene and gingival condition were excellent, it was decided to offer her tooth-colored posterior restorations in stress-bearing areas on an experimental basis.

Indications and contra-indications of the various methods available at the time were explained to the patient. These methods included (I) chairside-made composite inlays (32, 33); (II) lab-made composite inlays (32); (III) lab-made glass ceramic inlays (Dicor) (34); (IV) lab-made porcelain inlays; and (V) Cerec-System chairside-made ceramic inlays (19,20,35). Informed consent was obtained to replace the 13 amalgam restorations with Cerec-inlays and one onlay.

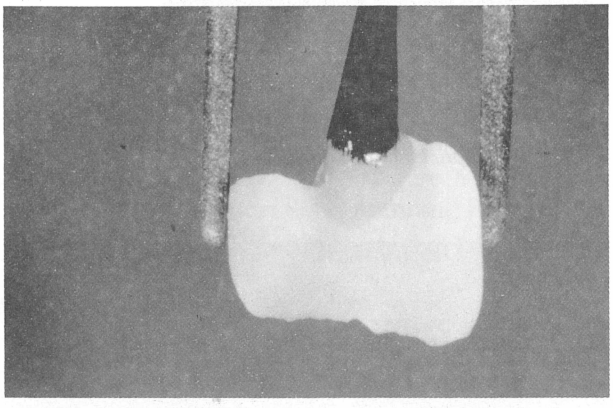

Fig. 6. *Bonding agent is added to the onlay.*
Slika 6. *Sredstvo za vezanje naneseno na onlay.*

Thirteen Cerec® – System ceramic inlays were placed during five visits within three months. Cavity walls were essentially prepared parallel to each other but the enamel margins were not bevelled. The gingival and lateral proximal enamel margins were short-bevelled by 45° to form adhesive margins for the bonding procedure. Occlusal enamel margins were not short-bevelled thus not extending the cementation interfaces reducing the potential loss of cementing composite. The inlays were milled from Vita-Cerec®ceramic blocks (Vita Zahnfabrik). The ceramic and enamel margins were etched with 5% HF (Cerec-Etch, Vita) and 35% H_3PO_4 (Esticid-Gel, Kulzer), respectively, and the inlays were finally

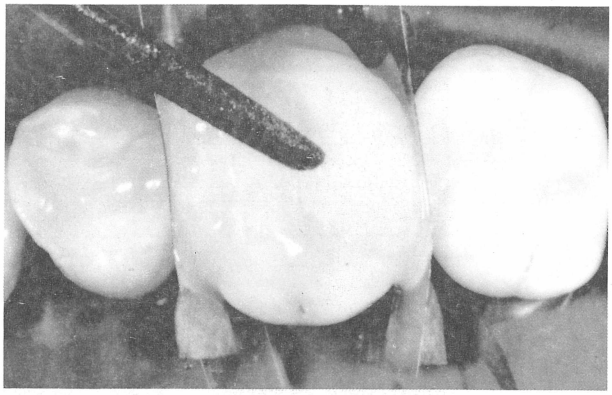

Fig. 7. *Onlay is »cemented« using dual cure fine hybrid composite resin (Cerec-Duo-Cement, Vita).*
Slika 7. *Onlay se »cementira« dvostruko polimerizirajućim finim hibridnim kompozitom.*

cemented using light-curing composite (Heliomolar, Vivadent), light transmitting wedges and transparent matrix bands (36, 37).

Figures 8 and 9, respectively, show details of the Cerec restorations in the maxilla and mandible five years after placement. In a previous report the thirteen Cerec ceramic inlays were subjectively evaluated by an independant clinical assistant (T G) using USPHS criteria modified to assess stress-bearing ceramic inlays after three years in place (8). The present report shows the clinical aspects of the same onlay and inlays after five years.

Discussion

This is the first reported case in which all the amalgam restorations were replaced with Cerec CAD-CAM ceramic inlays. The patient is on a 12-month recall, has maintained the excellent oral hygiene during the five years, and considers the »experiment« totally successful. The subjective clinical assessment after five years is excellent as judged from the clinical examination. Minimal defects along the cavity margins were seen, presenting equally as over- and underhangs, particularly on the occlusal surfaces. A slight discoloration in the central fissure of the upper left molar has developed (Fig. 8B). The color matches are unchanged as those noted at cementation, as only a minimal range of colors was available at that time. Currently, closer color matching is possible. Also a prototype unit was used to prepare the inlays and although extensive in vitro testing had been done at that point, our

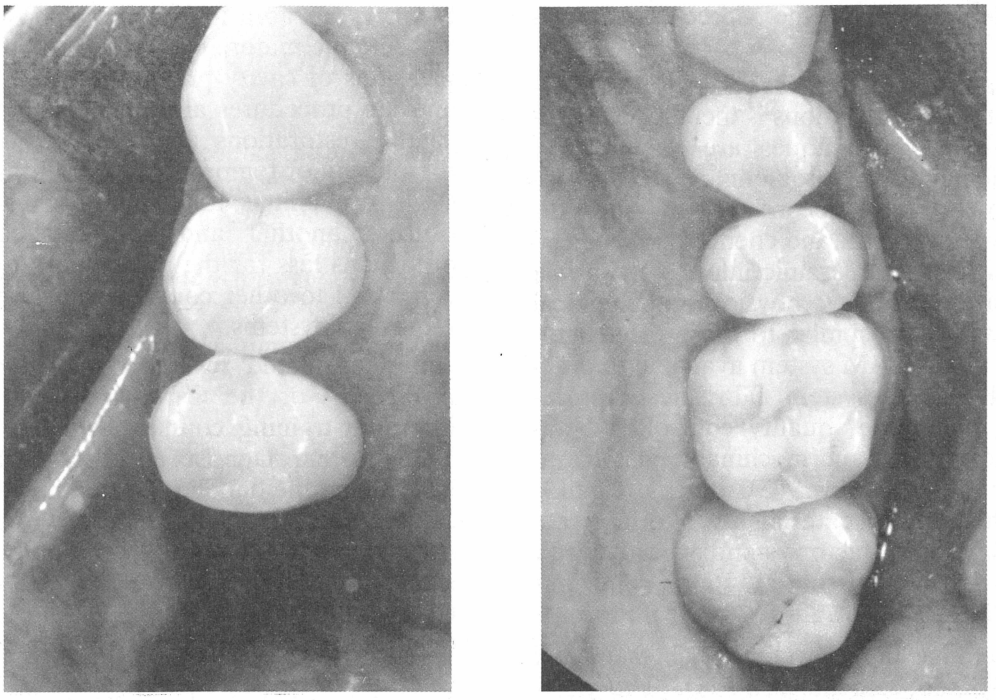

Fig. 8a,b *Overview of the 6 Cerec Inlays in the maxilla detailing the upper right (A) and left (B) quadrants.*

Slika 8a,b *Izgled 6 Cerec-inlaya u maxilli, desni (A) i lijevi (B) kvadrant.*

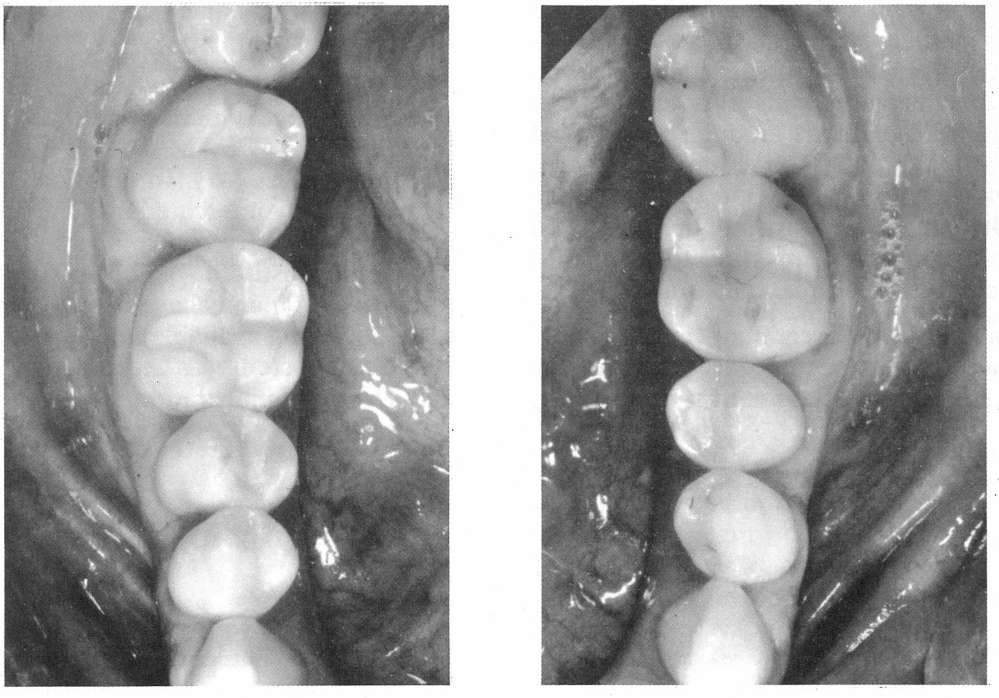

Fig. 9a,b *Overview of the 7 Cerec Inlays in the mandible detailing the lower right (A) and left (B) quadrants.*

Slika 9a,b *Izgled 7 Cerec-inlay u mandibuli, desni (A) i lijevi (B) kvadrant.*

clinical experience with the Cerec-system was limited.

The demand for esthetic tooth-colored stress-bearing posterior restorations is increasing. Several materials and techniques are available to meet this demand, but problems related to polymerisation shrinkage, secondary caries, insufficient resistance to wear, and chemical disintegration still persist (33). Ceramic inlays, in contrast to compoosite types, have physical and chemical properties which are similar to those of enamel. As the only CAD-CAM system available to practitioners, the Cerec-system fabricates restorations from high-grade, quality controlled Vita-Cerec ceramic blocks and machinable glass ceramic blocks (Cerec Dicor MGC-blocks, Caulk). Although the various materials used to fabricate indirect inlays are factory-standardized, their subsequent use by chairside assistants, clinicians and technicians has not always been uniform.

Etched ceramic bonds well to etched enamel using resin-based cements (38–43). The polymerization shrinkage and net thermal expansion of composite resin cement are low; only a thin layer of composite cement is needed between ceramic and enamel, producing minimal wall-to-wall tension (44).

Regardless of cavity size, simple box-shaped preparations suffice for the Cerec-system. Undercuts, which retained amalgams, need not be converted to divergent walls for Cerec-inlays thus conserving maximum amounts of enamel and dentin. In fact, the Cerec camera ignores undercuts when taking the »optical impresion« (7). generally, amalgam cavity margins only need refinishing and undercut areas are filled in with cementing composite during cementation.

The advantages of Cerec-inlays include long-lasting esthetic appearance (45) and at least a five-year material stability as shown in this case. Further, no abrasion of the opposing teeth by the ceramic material was clinically detected. Impressions of cavity preparations are unnecassary and lab procedures are not needed. In addition, as the restorations are cemented in one visit, the placing of temporary restorations is unnecessary. The unit is fully mobile from one dental office to another, and the number and duration of visits is less for the placement of Cerec-inlays compared to other conventional direct and indirect inlay systems.

System-related restrictions include the initial investment of the Cerec unit and the twoday intensive training course needed to master the Cerec-system. Dentists enrolled for these courses have found the handling of the three-dimensional camera and the management of the cavity design steps rather challenging in the multifacetted clinical situations. However, the new interactive Cerec operating system (31) has made Cerec-CAD very easy. Initial learning phases are fascinating and are no longer considered a system-related restriction. According to a manufacturer's report, Swiss and German dental practitioners indicate that they felt comfortable with the system right from the beginning using the new COS 2.0 operating system (31), whereas the placement of 50–100 ceramic restorations was needed to get proficiency using the start-up software.

Cumulated laboratory data (7, 32–35, 39, 43) and clinical evaluations (8, 45, 46) indicate that the Cerec CAD-CAM system is ready for use in dental offices (47). In addition, the Cerec-system is already integrated into the undergraduate operative dentistry course at the Zurich University Dental Institute. According to the manufacturer, over 700 units have been placed worldwide since becoming available in Europe in June 1988. The Cerec-system was accepted by the US Food and Drug Administration in June 1989.

CEREC® CAD-CAM KERAMIČKI INLAY-I

Sažetak

Opisane su tri različite tehnike za pripremu inlaya koji su dizajnirani (CAD) i izrađeni pomoću kompjutora (CAM). Ovaj rad pokazuje klinički slučaj kod kojeg je 13 Cerec CAD-CAM inlaya u funkciji pet godina. Cerec sustav omogućuje dizajniranje, izradu i postavljanje inlaya u jednom posjetu. Raspravljene su prednosti i ograničenja sistema.

Ključne riječi: *Keramički inlay-i, prikaz slučaja.*

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