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All-ceramic, chair-side computer-aided design/computer-aided machining restorations

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The Cerec 3 all-ceramic, chair-side computer-aided design/computer-aided machining (CAD/CAM) restoration system (Sirona, Bensheim; Germany) was introduced in January of 2000. After 1 year of clinical use and experience, hardware and software improvements were implemented in early 2001. Chair-side fabrication of ceramic inlays, veneers, partial and full posterior crowns and anterior full crowns was simplified and accelerated. Rapid occlusal and functional registration is possible, and proper occlusion can be established accurately. The separate form-grinding unit, working true to morphologic detail and with fine surface quality, is connected to the optical unit by radio control. The form-grinding unit can be equipped with a laser scanner for indirect restorations, and in April of 2001, it was expanded for fabrication of three-unit fixed partial denture frames. The Cerec 3 system is network- and multimedia-ready, and in combination with an intraoral color videocamera or a digital radiography unit, it can be used for patient education and user training. The Cerec 3 system is a diagnostic, restorative, training, and documentation center for the dental practice.

History

On September 19, 1985, the first ceramic inlay produced through a chair-side CAD/CAM procedure (Cerec 1, Brains, Zurich; Switzerland) was seated into a patient's tooth cavity at the Dental School of the University of Zurich. In 1994, Siemens (Bensheim, Germany) introduced the Cerec 2 unit. The expanded

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form-grinding technique permitted hard tissue conserving, defect-oriented fabrication of the inlays; coverage of cusps (partial crowns); and the establishment of a functional occlusal surface with efficient software. [1] In this fashion, design and fabrication procedures for all-ceramic posterior crowns were made possible. [2–4] The full effects of the "correlation" and "function" construction modes were limited by the restricted efficiency of the computer at that time, however. [5]

Development and improvements

For the Cerec 3, the construction and control software was written for the Windows NT and 2000 platforms (Microsoft, Mountain View, CA, USA) and now runs on an efficient personal computer integrated into the recording unit. The Cerec 3 is compatible with the rapid advances of computer technology in general, providing a practically unlimited computational performance. In turn, this compatibility permits acceleration of automatic processes and provides a sufficiently user-friendly program to accommodate the practitioner with ordinary technical skills. In particular, this means the elimination of all waiting periods for three-dimensional image adjustment, for data storage, and especially for matching of two optical impressions in the construction of occlusal surfaces with "correlation" and "function" modes. This system provides certainty in the attainment of functionally correct partial and full crowns and allows the use of the Cerec crown technique at a single appointment, consequently saving time.

All procedural steps benefit from the numerous simplifications and increased automation of the system. The separate form-grinding unit, which provides greater true detail than the Cerec 2 and is fitted with one cylindrical and one tapered diamond rotary tool, is controlled by radio communication from the control unit. The form-grinding unit receives data from the control unit, independent of its location in the office. The next restoration can be designed while the first is being milled. The form-grinding unit is fitted with a laser scanner (Cerec Scan, Cerec inLab Sirona) and can be used by itself with a standard personal computer for indirect application. With its direct optical impression, the Cerec 3 once again puts the dentist in the center while it permits joint efforts with the dental assistant and cooperation with the dental laboratory technician.

The expansion and combination of the Cerec 3 system with the Sirocam intraoral camera (Sirona) and the Sidexis digital radiography system (Sirona) proved to be very practical. Optical impressions and designs were transmitted without problems through e-mail. The authors had the opportunity to use a Cerec 3 system for 18 months. This article describes their clinical experience with this system.

Intraoral three-dimensional scanning camera

The Cerec 3 system (Sirona) has several technical improvements when compared with Cerec 2, including the intraoral three-dimensional scanning camera, the image processing, the computing power, and the form-grinding unit. The most significant factor for three-dimensional scanning with the Cerec 3 intraoral camera is that tooth preparations for crowns and inlays have a unique characteristic: all points of interest can be seen from a single viewing line, representing the preparation and insertion axes, respectively. The technical requirements as devised by Mörmann and Brandestini [6,7] for the Cerec method and met by Cerec 1 and Cerec 2 are also met by Cerec 3. Intraoral three-dimensional scanning proceeds as follows:

1. With a single exposure from a single viewing angle of the camera.
2. Without touching the preparation (the camera is guided in the manner of a contra-angle).
3. In a freehanded manner (the camera is supported bimanually on the dental arch).
4. Without reference markings on the teeth.
5. In fractions of a second.
6. As often as desired, reproducibly.

The inventors of this procedure called it an *optical impression,* in analogy to the physical impression and model technique. [6,7] After the scanning procedure is completed, the data are stored as a positive digital xyz data model and displayed as a video freeze-frame image, or *optical impression*. The design lines are entered on this image, the optical impression.

Scanning principle

The Cerec three-dimensional intraoral scanning method uses the principle of "active triangulation." In this procedure, the camera projects a linear pattern under a triangulation angle on the preparation, and the projected image is recorded. When the projected lines on the preparation are viewed, the course of the lines no longer appears to be straight, but rather appears shifted locally, the amount of shift depending on the depth of the preparation. The surface sensor in the camera registers this line shift, and the computer calculates the corresponding depth. The depth scale in this procedure depends on the angle of triangulation, among other factors. In the Cerec 2 camera, the survey region depth scale is limited to a single value of 6.4 mm. In the "adjust" mode and with time-consuming effort required for software-supported adjustments, the depth scale can be stretched beyond the limits of the camera's optical depth of field of 14 mm. In the Cerec 3, the problem is solved through "double triangulation." In this procedure, the triangulation projection of the single optical impression is registered with two separate triangulation angles, leading to a clear, expanded depth scale of 20 mm. The double set of data is processed immediately through a specialized "twin grab board" (Table 1), rendering tedious adjustment procedures unnecessary.

Table 1
Technical characteristics of the Cerec 3 recording and design unit

New technology	Property	Advantages
Cerec camera		
Principle: Active double triangulation. Recording of the cavity from two different triangulation angles provides immediate depth scale of > 20 mm.	Eliminates adjusting procedure.	Saves time, especially in the two impression techniques, techniques, function, and correlation.
Image processing		
Rapid "twin grab board" for the Cerec intraoral measuring camera.	Provides vertically oriented optical impression on the oblong format monitor.	Eliminates relearning for previous users; eliminates waiting time.
Computer		
Medically approved personal computer with shock-protected hard disk, Pentium III processor, 733 MHz, 128-MB RAM, 20-GB hard disk; CD-ROM; 1.44-MB 3.5-inch disk drive; accessory ports; one parallel, one serial; 2x USB Ethernet, RJ45TP, 100; MB; radio control optional.	Incorporates great versatility and efficiency of the Windows system; network ready.	Eliminates waiting time in design; performs grinding and construction simultaneously; makes patient data available through Sidexis and network connection; allows use of other programs.

Computer-aided design

The time-consuming adjustment required to increase the depth scale in the adjust mode is eliminated in the Cerec 3. Owing to computer efficiency, the two-impression "correlation" and "function" modes for designing partial and full crowns now can proceed as desired using occlusion and preparation optical impressions without loss of time. The rapid recording of occlusal impressions from an existing intact occlusal surface undermined by extensive caries or from a fully functional occlusal surface of an existing restoration that is to be replaced is possible in the correlation mode, with a significant decrease in time. For a large carious lesion with loss of cusps, and when the occlusal surface is insufficient, the situation can be recorded in the "function" design mode. The remaining intact cusps and parts of the occlusal surface are recorded by an "occlusion impression," and after preparation they are matched with the "preparation impression." Consequently, the occlusion and the preparation images can be used alternately to fit design suggestions arising from the morphologic data bank to the individual situation. Alternatively, a functionally generated path [8] or centric wax registration can be recorded by an occlusion impression and matched with the preparation impression for designing the occlusal surface (e.g., of a full crown).

Preliminary time measurements showed significant time advantages for Cerec 3 compared with Cerec 2. For example, for design and grinding of a partial crown with replacement of three cusps (three-quarter crown), Cerec 3 required only 24 minutes, whereas Cerec 2 required 33 minutes under the same conditions, a 27% time saving (Table 2). Another time-saver, which has not yet been quantified but is clinically obvious, is related to the occlusal fit of the correlation and function restorations. In the correlation mode, the Cerec 2 system required a significant expenditure of time, [9] which presently is being reduced to the unavoidable minimum (correlation and function) with the Cerec 3 system.

Computer-aided machining

Separation into the chair-side Cerec 3 recording and design unit and the Cerec 3 form-grinding unit (Fig. 1) was the result of user considerations and the possibility of using a proven radio control system (Table 3). Cerec 3 is therefore a CAD/CAM system that may be used as desired in the dental practice. In 18 months of clinical experience with routine use, the radio control system allowed the operation to be free from disturbance, regardless of the location of the units in the office. In the dental practice, the location of the devices is determined by the availability of space for the separate functions. The system's versatility and flexibility in use should fulfill the needs of

Table 2
Fabrication time (min) of a partial crown with replacement of 3 cusps (N = 3)

Program	Cerec 2 *Mean (SD)*	Cerec 3 *Mean (SD)*
Extrapolation		
Crown 1.x software for Cerec 2 and Cerec 3 crown software, both with morphologic proposal means, one optical impression, design, and grinding of form.	32.96 (1.08)	23.68 (1.04)
Correlation		
Cerec 2 1.x correlation software, Cerec 3 crown program, both with morphologic proposal means; two optical impressions, design, and grinding of form.	33.82 (0.82)	23.24 (0.34)
Function		
Cerec 3 crown software with morphologic proposal means; preparation and functional im pressions, design, and grinding of form.	—	24.82 (0.49)

Fig. 1. Cerec 3 recording and design and Cerec 3 form-grinding unit.

a broad user spectrum. For example, work can continue with the design unit while form grinding is carried out by the form-grinding unit.

The computer-controlled, double form-grinding unit dispenses with the grinding wheel and uses two individual rotary diamond grinding tools, each of which is coated with 64-μm grit diamonds. The cylindrical floor- and wall-grinding diamond is 1.6 mm in diameter, as previously used in the Cerec 2 unit, or 1.2 mm for form grinding anterior tooth crowns. A tapered cylindrical diamond is used to shape the occlusal surface of the restoration. The angle of taper is 45°. The two instruments act together symmetrically in

Table 3
Technical characteristics of the Cerec 3 grinding unit and the radio control communication to the recording and design unit

New technology		Property	Advantages
Double grinding unit			
Grinding instruments	1.6-mm cylindrical diamond and 1.6-mm cylindrical diamond with 45° taper angle on top.	Provides an occlusal design that is true to detail.	Saves time in finishing of occlusion.
Control of grinding	Symmetric grinding by the instruments. Predictive control of advance and real-time load detection.	Allows tension-free grinding, reducing stress on ceramic and grinding instruments.	Places less stress on ceramic. Protects the grinding instruments.
Length of restoration	32 mm maximum at present; prepared for 38 mm.		Allows form-grinding of fixed partial denture frames.
Radio control communication			
Security	1-m distance to other electric devices.	Allows cable-free bidirectional data transfer to grinding unit.	Allows placement of Cerec 3 unit components as desired.
Effective range	50 m in closed room; 300 m outside.		Allows radio control of the grinding unit while the next design is generated on data acquisition and control unit.
Power	10 mW		
Connector	V24/RS 232		

the shaping process. The control of anticipated forward movement and the real-time load detection permit tensile load-free grinding, even of thin parts. The Cerec 3 unit allows more flexible and more true-to-detail form grinding than is possible with Cerec 2. In turn, these characteristics lead to better fit of partial crowns overall. Moreover, Cerec 3 provides morphologically better adaptation and better appearance of the occlusal design.

Semichair-side and laboratory computer-aided design/computer-aided machining

The Cerec Scan/inLab unit consists of the Cerec 3 grinding unit with a laser-point sensor mounted on the drive motor of the tapered bur (Fig. 2; Table 4). With this device, a dental cast of a clinical situation (e.g., a mesio-

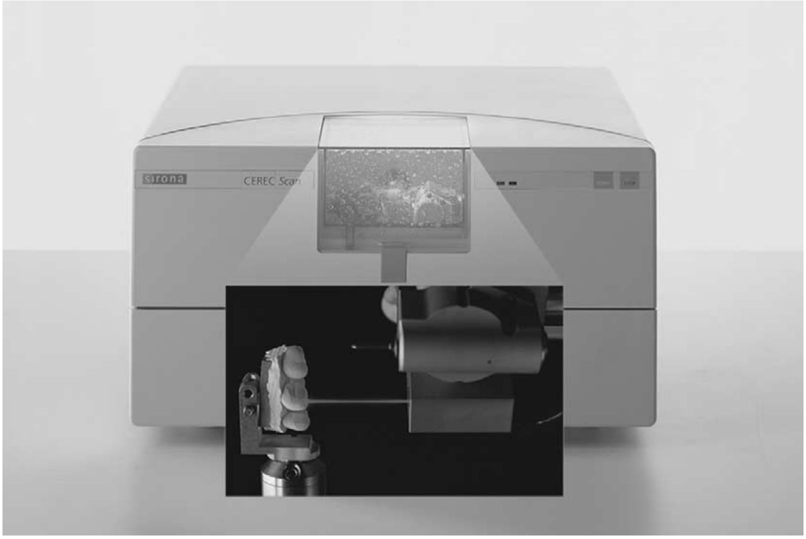

Fig. 2. The Cerec scan/inlab unit consists of the Cerec 3 grinding unit with a laser-point sensor mounted on the drive motor of the conical bur.

disto-occlusal cavity of a third molar) can be scanned three-dimensionally, line by line, in approximately 5 minutes. The procedures for rapid impression and cast fabrication at the chair-side are not described in this article. The scanning process is controlled by Cerec 3 software and proceeds in two steps with different angulations. This process makes the scanning dependable and corresponds to the measuring precision of the Cerec 3 camera. Construction proceeds with Cerec 3 software directly on the scan view, analogous to the well-known procedure (Table 5). Running the program requires a standard personal computer or laptop with high capacity and interfaces as they exist for the three-dimensional recording and construction unit.

Case reports

In an 18-month trial, approximately 750 patients were treated with the various types of Cerec 3 restorations by eight dentists. The clinical application of the technique is described through two case reports.

Case 1: chair-side inlays and partial crowns

A 39-year-old woman desired replacement of all existing amalgam restorations with ceramic restorations (Fig. 3). All teeth in question were vital. The two-surface occlusodistal inlays of the upper right and left premolars were designed and placed in one session. After removing amalgam, no secondary caries was present and only minimal cutback was necessary to

Table 4
Technical characteristics of the Cerec inlab computer-aided design / computer-aided machining unit

Technology	Property	Advantages
Laser scanner		
Laser triangulation scanner with small triangulation angle, focused measuring region with digital sensor guidance in the Cerec 3 grinding unit, controlled laser intensity.	Creates line-by-line three-dimensional model in minutes.	Cost-saving three-dimensional process. Provides same precision as Cerec 3 technique.
Cerec Scan grinding unit		
Cerec 3 grinding unit with built-in laser scanner	Uses Cerec 3 grinding controls.	Allows rapid fabrication of single-tooth restorations and three-unit fixed partial denture frames.
Restoration length: 32 mm maximum at present; prepared for 38 mm.	Allows scanner and grinding to shape in a single unit.	Can be controlled from the recording and design unit.
Computer		
Standard personal computer and monitor or laptop, with performance capabilities and connectors for three-dimensional picture and design unit.	Provides design and control of shaping.	Allows use of existing equipment.
Software		
Cerec 3 design software	Preferably extrapolation.	Allows cost-effective use.

fabricate and seat the premolar Cerec 3 inlays. After removal of amalgam in the upper right first and second molars, buccal walls were judged too thin, and cusps were shortened by 2 mm for coverage. Partial crowns with buccal cusp coverage were fabricated with Cerec 3 and placed in separate appointments for each molar. One additional appointment was needed to replace the upper left first and second molar amalgams with Cerec 3 CAD/CAM mesio-occluso-distal inlays. The inlays and partial crowns were designed directly on the three-dimensional optical impressions as captured from the individual preparations using the three-dimensional intraoral scanning camera and displayed on the screen of the Cerec 3 design unit. Vitablocs Mark II (feldspathic ceramic) shade A2C (Vident) were used for machining of the ceramic restorations throughout this particular case. The machined inlays and partial crowns were tried in, strong proximal contacts were adjusted, and proximal surfaces were polished.

Enamel and dentin surfaces of the cavities were prepared for adhesive placement using the Syntac classic adhesive system (Ivoclar-Vivadent) as

Table 5
Technical characteristics of the Cerec 3 software and Cerec link

Technology	Property	Advantages
Cerec 3 inlay		
Standard software for Cerec 3 and Cerec Scan/inLab	Allows inlay and onlay design with extrapolation and correlation modes.	Suffices for conservative treatment.
Cerec 3 veneer		
Supplemental software for Cerec 3	Allows fabrication of Veneers.	Supplements standard software.
Cerec 3 crown		
Design software for Cerec 3 and Cerec inLab for fabrication of posterior tooth inlays, half, three-quarter, and complete crowns, and anterior tooth crowns and veneers, three-unit fixed partial denture frames.	Contains extrapolation, correlation, and function design modes.	Provides complete software package for the full range of applications.
Cerec link		
Software for design of Cerec 2 restorations on a personal computer or laptop.	Contains Cerec 3 software.	Provides Cerec 3 design comfort to Cerec 2.

recently described [10]. The lower parts of the ceramic inlays and partial crowns were etched and silanized. A high-viscosity ultrasonic insertion technique [11] was used with light-curing posterior resin composite Tetric (Ivoclar-Vivadent) as luting material and the Siroson (Sirona) ultrasonic handpiece. After curing, the rubber dam was removed, and excess luting composite was removed with Proxoshape files (Intensiv; 40-μm and 8-μm grit) and with flexible disks (Sof-Lex, 3M Dental). The centric occlusion was checked with Hanel foil and adjusted where necessary. Protrusion, mesiotrusion, and laterotrusion were checked with foils (Hanel) of a different color, and adjustments were made as required. The goal was to achieve interference-free static and dynamic occlusion. The rough surface areas resulting from the grinding adjustments were smoothed with flexible Sof-Lex disks, rotating brushes (Occlubrush, Hawe-Neos), and diamond polishing paste (Shofu Dental). The clinical situation after replacement of the amalgam by Cerec 3 CAD/CAM restorations is shown in Fig. 4.

Case 2: chair-side partial and full crowns

A 44-year-old man needed replacement of insufficient amalgam and composite resin restorations and augmentation of the heavily abraded upper right and left premolars and molars, including the reconstruction of the

Fig. 3. Patient desires replacement of all existing amalgam restorations with ceramic restorations.

Fig. 4. Clinical situation after replacement of the amalgams by Cerec 3 all-ceramic (Vita MK II) CAD/CAM restorations.

occlusal morphology and raising of the vertical dimension (Figs. 5 and 6). The patient requested having his teeth restored with a natural-looking, durable material. The upper Cerec partial and full crowns were planned to be CAD/CAM fabricated at the chair-side. Because the correct occlusal morphology was lost and to allow the two-optical impression "correlation" design mode to be used at the chair-side, the first step was to obtain a model of the upper arch, and wax-ups were built on both left and right first premolars and molars on this model.

Fig. 5. Upper right: insufficient composite resin restoration in first molar and heavily abraded premolars.

Designing a full crown on screen

At the first appointment, in the upper right a full crown on the first molar and a partial crown at the first premolar were CAD/CAM fabricated at chair-side. First, the rubber dam was placed and old restorations were removed. The first molar was nonvital and had a state-of-the-art root canal filling. An endocrown preparation [12] was completed, and the correlation design mode was chosen on the screen. Immediately after, an optical impression was taken intraorally (Fig. 7). The mesial and distal reference proximal contact lines were entered, and the bottom line was drawn exactly on the circular outer margin of the preparation (Fig. 7). The reference proximal contact lines help with aim when taking a second optical impression from the same view. To get the waxed-up occlusion into the construction of the crown, an optical impression of the wax-up was taken. When taking a second optical impression in the correlation mode, the reference proximal contact lines as entered in the preparation optical impression are being displayed on the monitor. They assist the practitioner in finding the same

Fig. 6. Upper left: insufficient amalgam restorations and heavily abraded upper premolars.

viewing position for the three-dimensional camera. Because the model of the contour of the neighboring teeth (second premolar and second molar) is the same as in the mouth, a match can be found easily. The computer then immediately matches the three-dimensional data of the preparation and occlusion optical impressions.

Between the three-dimensional data of the preparation and of the occlusion, there is a gap of data concerning the proximal contact areas and the buccal and lingual surfaces of the crown that requires completion by design. The system therefore presents a proposal for a proximal contact line from its tooth library (Fig. 8). This one can be manually modified if necessary, and strong proximal contacts can be fitted to the neighboring teeth (Fig. 8). In the final design step, the system presents the occlusal copying line (Fig. 9). The course of the copying line decides to which extent the three-dimensional data from the occlusal optical impression will definitely be taken into the construction to determine the occlusal morphology of the crown. Selecting the "swap" icon allows switching the preparation optical impression to the

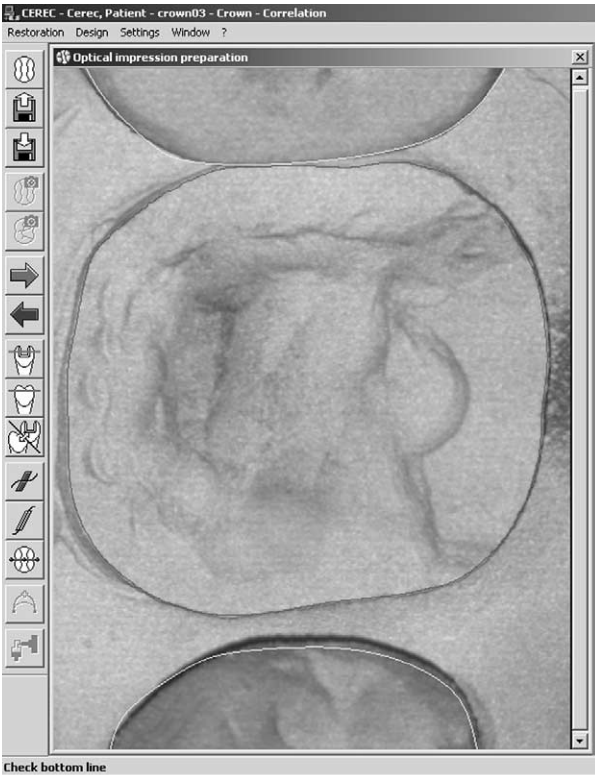

Fig. 7. Optical impression; bottom line drawn exactly on the circular outer margin of the preparation, mesial and distal reference proximal contact lines at neighboring teeth.

occlusion optical impression on the screen for optimal fitting of the copying line (Fig. 10). The user normally tries to expand the copying line beyond the cusp tips to include as much data from the external cusp walls as possible. The final design of the endocrown is then controlled by using the section window. The section, as displayed in Figure 11, can be scrolled mesiodistally through the entire construction. Going a step further by selecting the "advance" icon tells the system to finalize the calculation of the crown. Crown calculation is effectuated immediately, and when the user selects the "machining" icon, the system proposes the size of the ceramic block that fits closest to the dimensions of the crown.

Multitasking computer-aided design/computer-aided machining

In Case 2, block size I 12 was appropriate, and materials such as Vita Mark II (Vita) feldspathic ceramic and ProCAD glass ceramic are available. ProCAD shade Chromascope 200 was chosen for this particular patient and entered into the form-grinding chamber of the Cerec 3 machining unit

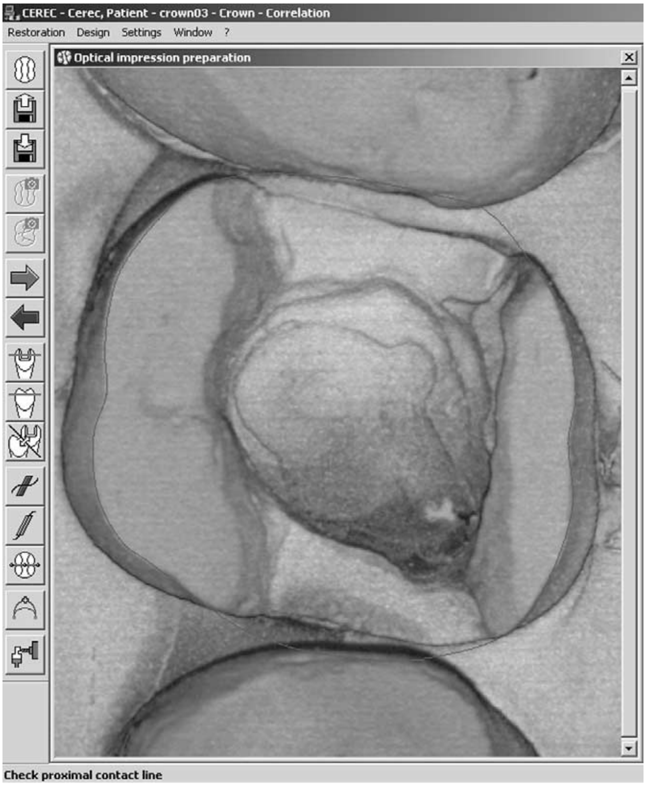

Fig. 8. System presents a proposal for a proximal contact line from its tooth library.

(Fig. 12). While the crown was being machined, the dentist prepared the first premolar for a partial crown. The multitasking capability of the Windows 2000 operating system allowed opening another Cerec 3 task and taking an optical impression of this new preparation as well as designing the partial crown. [10] After 18 minutes, the all-ceramic molar crown was completed, and the machining of the partial premolar crown was started. This system enabled efficient restorative working.

Adhesive seating

The internal surfaces of the all-ceramic crown were etched with Ceramics-Etch (Vita) and silanized with Monobond (Vivadent). The tooth was prepared for adhesive restoration with the Syntac-Heliobond system (Vivadent), as previously described by Bindl and Mörmann. [12] The crown was bonded with Variolink Ultra Base (Vivadent) and polymerized for a total of 6 minutes with the Heliolux DLX polymerization lamp (Vivadent). [13] After the rubber dam was removed, excess luting composite was removed with Proxoshape files (Intensiv, 40-μm and 8-μm grit) and with flexible disks

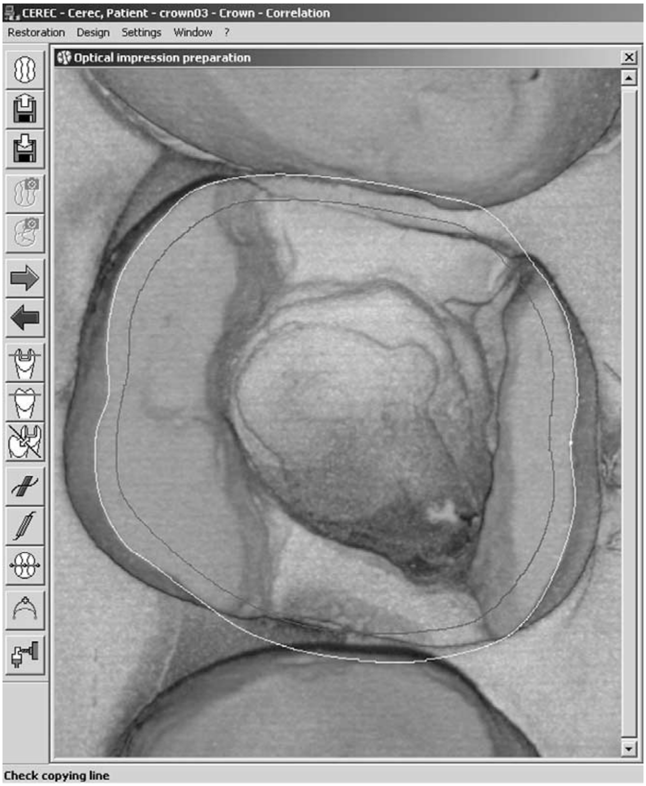

Fig. 9. In the final design step the system presents the occlusal copying line.

(Sof-Lex, 3M Dental). The centric occlusion was checked with Hanel foil and adjusted where necessary. Protrusion, mesiotrusion, and laterotrusion were checked with foils of a different color, and adjustments were made as needed. The goal was to achieve interference-free static and dynamic occlusion. The rough surface areas resulting from the grinding adjustments were smoothed with flexible disks (Sof-Lex), polishing brushes (Occlubrush; Hawe-Neos), and diamond polishing paste (Porcelain Paste; Shofu Dental). The clinical situation after restoring both premolars and the first molars in both maxillary quadrants by Cerec 3 CAD/CAM restorations is shown in Figs. 13 and 14.

Discussion

Evaluation of innovations, particularly in dentistry, is directed toward the practical usefulness of the newly available product. For the Cerec 3 system, the innovation is found in the technical improvement in all components. The improvements are reflected in increased processing quality and

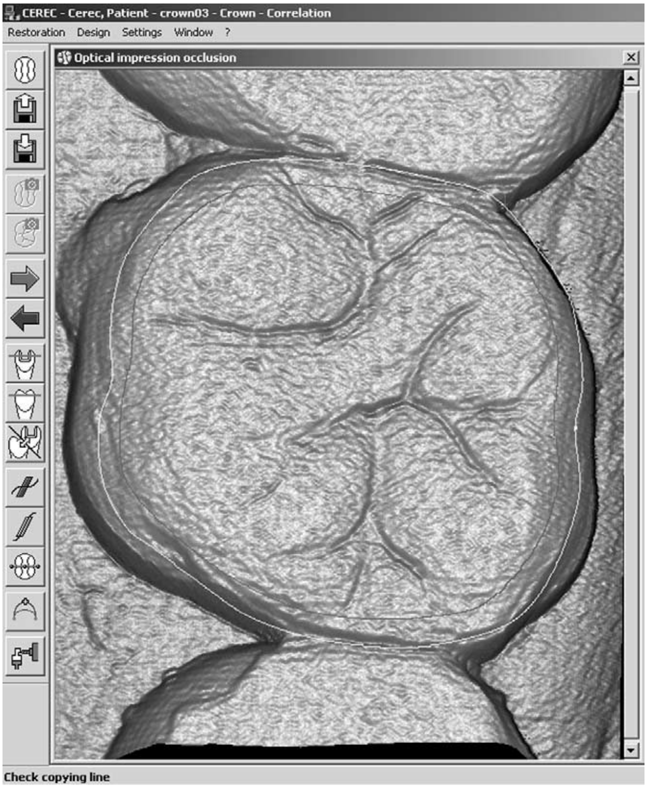

Fig. 10. Occlusion optical impression on the screen for optimum fitting of the copying line.

processing expansion. These enhancements provide clear improvements in the quality of the ceramic restorations with natural morphology and fine surfaces and their adaptation to individual tooth preparations. The product design is the result of 14 years of development. [14]

The improved optical-measuring process eliminates the required adjustment of the depth scale. The benefit lies not only in time saved but also in the enormous simplification of use. A number of previously required operating steps—the physical reasoning for which was complicated—are eliminated. The main difficulty in operating the Cerec was therefore definitively overcome, regardless of whether the optical impression was applied directly in the oral cavity or indirectly in the dental laboratory. In every case, the dentist decides in accordance with his or her clinical and practical experience whether he or she wants to work directly or indirectly with Cerec. [15]

It was the intention of the initial developers to provide the dentist with this sort of versatile technology. [6,7] The Cerec 3 system continues this philosophy while supporting both methodologic alternatives. For the user experienced in direct (chair-side) applications, the completely optimized and

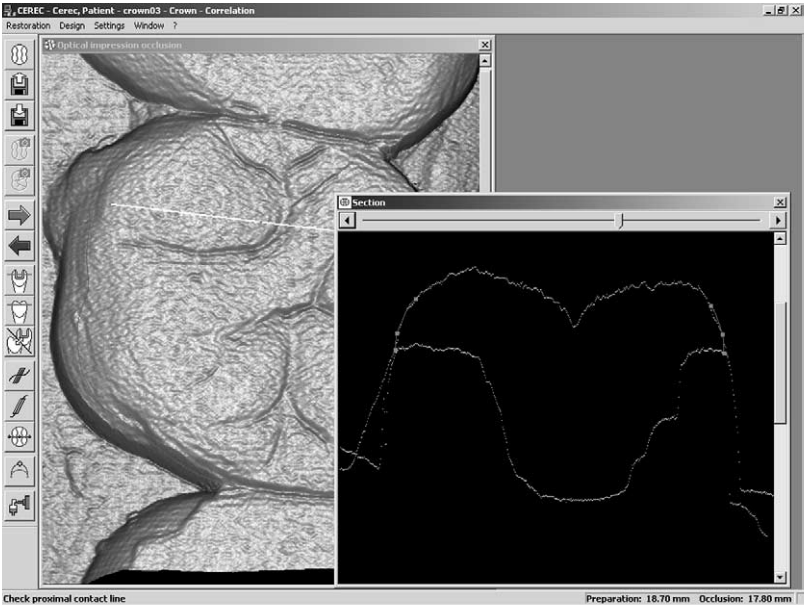

Fig. 11. The final design of the endo-crown is then controlled using the section window.

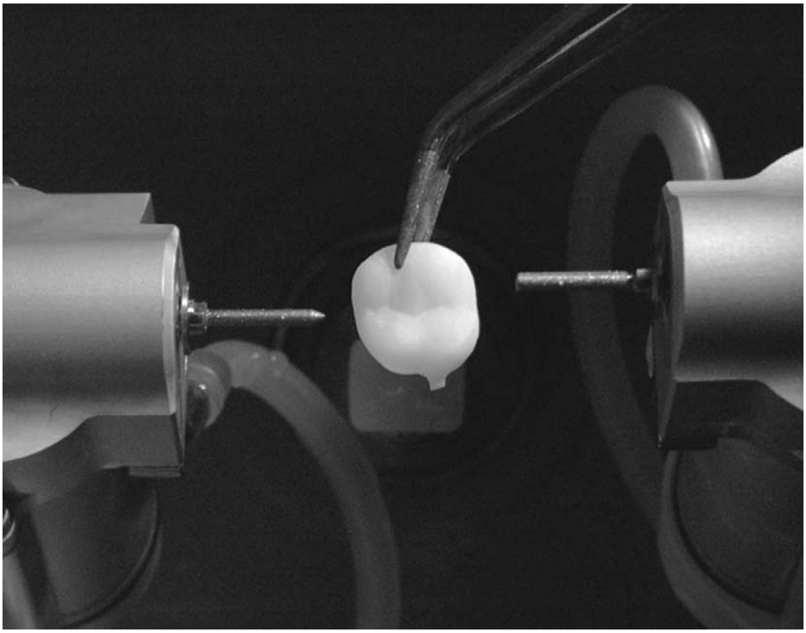

Fig. 12. Form-grinding chamber of the Cerec 3 machining unit with machined crown.

Fig. 13. The new clinical situation after restoring both premolars and the first molar in the upper right quadrant (Fig. 5) by Cerec 3 CAD/CAM restorations.

accelerated design (with simultaneous control of projection and section views), the elimination of image adjustments, and the rapid superimposition of occlusal registrations are beneficial. These qualities make precise, relaxed work with perfect results a reality, which is true for complete-quadrant restorations as well.

Scientific recognition of the Cerec method is based on in-vitro [16–18] and in-vivo studies [19–21] evaluating the quality of inlays and onlays in private practice. The often-repeated, so-called inferiority of the direct intraoral optical impression to optical scanning of the model can be attributed, in the authors' opinion, to the extent of practice or the preference of the user rather than to deficiencies in the measuring technology. [15,22] Studies also

Fig. 14. The new clinical situation after restoring both premolars and the first molar in the upper left quadrant (Fig. 6) by Cerec 3 CAD/CAM restorations.

confirm this in terms of precision of fit of Cerec 2 crowns and their clinical quality. [2–5,9,12,23,24] This clinical trial did not reveal any differences in precision of fit between Cerec 3 and Cerec Scan/inLab for inlays, partial crowns, or full crowns. In view of the computing capacity of Cerec 3 and the related potential for expansion in superimposition and split-screen viewing of optical impressions, a broad spectrum of development is available for both direct and indirect fabrication of fixed partial dentures. [14,22]

Cerec Scan/inLab increases the flexibility of the product and the number of possibilities for its use. It can be operated with an existing personal computer or laptop. Cerec Scan/inLab makes fabrication of single-tooth restorations possible as well as complete-quadrant production, and since April of

2001, three-unit fixed partial denture frames can be designed. Form grinding of a fixed partial denture-frame uses In-Ceram Zirconia ceramic (Vita) in its porous state. The fixed partial denture-frame is then fired and infiltrated with lanthanum glass, providing high strength to this structure. [25] Cerec Scan/inLab offers practitioners with technically and financially limited resources the opportunity to use CAD/CAM technology indirectly or semi-chair-side for a start. Later expansion with the Cerec 3 intraoral camera and control unit provides a sensible build-up of the system. The Cerec 3 software also can be used with an existing personal computer or laptop and the Cerec 2 unit, making it possible for the Cerec 2 user to learn the Cerec 3 software and to construct additional restorations while the Cerec 2 unit is form grinding.

The change in the form-grinding system from disks to a cylindrical floor bur and a conical occlusal machining bur was made deliberately in the interest of a more flexible shaping technique, one that is better adapted to the individual tooth preparation and that can replicate the occlusal morphology better. The special instrument control provides longer life for the diamonds and is more economical. High value is provided for the system not only through the use of a standard computer and operating system but also by the possibility of adding the Sirocam intraoral color videocamera and the Sidexis digital radiography system. It is also a multimedia system, suitable for user training and patient education. This combination of the Cerec 3 system is a center for diagnosis, restoration, training, and documentation in the dental practice.

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