All-ceramic restorations in different indications

A case series

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Clinicians use all-ceramic restorations routinely in dentistry today. The rapid rate of innovation with regard to materials, computer-aided design/computer-aided processing (CAD/CAM) technologies, and intraoral data acquisition systems has resulted in the need for dental care professionals to familiarize themselves with a large body of knowledge to make use of the almost limitless possibilities that these systems offer.

Conventional steps, such as careful treatment planning in collaboration with the laboratory technician, selection of appropriate ceramic materials, and adequate tooth preparation and processing are essential to ensuring the long-term survival of restorations. Furthermore, rapid advances in material technology in the field of glass and oxide ceramics, as well as in adhesive technologies, have led to new treatment options that are reflected in an extended range of indications and in less invasive tooth preparation designs. All-ceramic systems are suitable for a wide range of indications covering almost all areas of fixed restorative dentistry, and they encompass a diverse range of materials.

We present five cases ranging from placement of veneer restorations to complex rehabilitation to illustrate the scope of applications and procedures used to achieve successful outcomes with all-ceramic restorations. Close collaboration between the patient, dentist and laboratory technician is paramount to define and achieve the treatment goal. An analytic wax-up, a diagnostic template derived from the study wax-up and modifiable temporary restorations facilitated communication, decision making and subsequent preparation procedures.

ABSTRACT

Background. Encompassing a vast array of materials, today's all-ceramic systems are suitable for a large range of indications in almost all areas of fixed restorative dentistry.

Methods. The authors describe five clinical cases involving different indications to illustrate the use of different ceramic materials and combinations of materials. They describe the collaboration between the dentist and dental technician for single-tooth restorations and for complex cases, including all stages of the restorative procedures from treatment planning with an analytic wax-up to the selection of appropriate materials, tooth preparation and cementation).

Results. The patients described experienced significant functional and esthetic improvement, even those who had severely discolored teeth. This was possible because the authors executed the working steps in a strictly synchronized manner and selected the restorative materials carefully to meet the specific needs of each patient.

Conclusions. All-ceramic systems have expanded the range of restorative treatment options significantly; at the same time, their handling has been simplified substantially. The use of glass-ceramic– and zirconium oxide–based frameworks along with an identical veneering ceramic enables the dental care professional to cover almost all indications in fixed prosthodontics while achieving the same esthetic results.

Key Words. Lithium disilicate glass-ceramic; zirconium oxide; fluorapatite veneering ceramic.
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Figure 1A. Try-in of veneers in the anterior region of the mandible fabricated on refractory dies by using a fluorapatite-based veneering ceramic (IPS e.max Ceram, Ivoclar Vivadent, Amherst, N.Y.). Preparation was guided by a mock-up, fabricated according to an analytic wax-up. **B.** Postoperative view after definitive placement of the veneers with the use of a multistep dentin adhesive system combined with a light-curing luting composite for veneers.

VENEERS FABRICATED ON REFRACTORY DIES

Because of their excellent clinical performance, outstanding esthetics and minimally invasive characteristics, resin-bonded veneers offer an excellent treatment option for a wide range of indications.[1] Porcelain veneers are considered advantageous for maintaining tooth vitality and preserving hard tissues,[2] especially if tooth preparation is guided by a diagnostic template and includes the use of an additive wax-up.[3] Full crown preparations require removal of 63 to 72 percent of tooth structure, while veneers require removal of only 3 to 30 percent of tooth structure.[4]

Case 1. A 30-year old man visited his dentist (D.E.) because of general defects of his tooth structure. The patient requested to have the brightness value of his teeth improved permanently and to undergo esthetic reconstruction to improve the morphology and function of his teeth. After the dental technician created a study wax-up, the dentist and the technician decided to use all-ceramic single-tooth restorations to achieve the patient's treatment goal. The diagnostic template, which had been created on the basis of the wax-up, served as a guide for preparation of the teeth.

The minimum reductions in tooth structure during tooth preparation were as follows: cervical area, 0.4 millimeter; equatorial area, 0.7 mm; and incisal area, 1.2 mm (Figure 1A). The laboratory technician used a fluorapatite-based veneering ceramic (IPS e.max Ceram, Ivoclar Vivadent, Amherst, N.Y.) and layering technique to produce the veneers on refractory dies. The dentistry performed try-in by using tooth-colored pastes (Variolink Veneer Try-In Paste, High Value +2, Ivoclar Vivadent), and he performed the final adhesive cementation procedure by using a multistep dentin adhesive system (Syntac Primer and Syntac Adhesive, Ivoclar Vivadent) combined with a light-curing luting composite for veneers (Variolink Veneer, High Value +2, Ivoclar Vivadent) (Figure 1B).

ALL-CERAMIC INDICATIONS IN THE ESTHETIC REGION

Esthetically demanding cases requiring the use of different all-ceramic framework materials present a challenge for the dental restorative team.

Case 2. A 42-year-old man who exhibited several anterior defects of varying degrees of severity and had lost tooth no. 6 required a functional and esthetic rehabilitation of the maxillary anterior region from tooth no. 5 to tooth no. 11. Because of varying degrees of damage to the teeth and the patient's high esthetic expectations, the treatment team (including D.E. and O.B.) opted to place the following restorations and materials (Figure 2):

- right first premolar to right lateral incisor: zirconium oxide–based three-unit fixed dental prosthesis (FDP) (IPS e.max ZirCAD, Ivoclar Vivadent);
- central incisors: circular prepared veneers with a minimum thickness of 0.3 mm composed of lithium disilicate glass-ceramic (IPS e.max Press, LT, Ivoclar Vivadent);
- left lateral incisor and left canine: full-crown restorations composed of lithium disilicate glass-ceramic (IPS e.max Press, LT).

Because the dental team used the same veneering ceramic (IPS e.max Ceram) for all of the restorations, they were able to achieve a uniform esthetic appearance throughout the dentition. Consequently, an observer would be

ABBREVIATION KEY: CAD/CAM: Computer-aided design/computer-aided manufacturing. **FDP:** Fixed dental prosthesis. **VDO:** Vertical dimension of occlusion.

unaware of the fact that various ceramic materials had been used for the frameworks (Figure 3). The clinician used the following luting materials for adhesive cementation of the restorations: primarily chemical curing luting material containing phosphonic and acrylic acid monomers (Multilink Automix, AdheSE One F, Monobond Plus, Ivoclar Vivadent) for the zirconium oxide–based three-unit FDP; light-curing resin cement for the glass-ceramic full veneers (Syntac Primer and Syntac Adhesive, Variolink Veneer, High Value +2, Ivoclar Vivadent) and dual-curing resin cement for the glass-ceramic crowns (Syntac Primer and Syntac Adhesive, Variolink II Base and Variolink II Catalyst, transparent white 110/A, Ivoclar Vivadent).

RECONSTRUCTION OF VERTICAL DIMENSION OF OCCLUSION

Case 3. Tooth wear is an increasing problem all over the world.[5] A 28-year-old man wanted to improve the esthetics and function of his dentition, which had been damaged severely by abrasive-erosive processes. He complained about experiencing hypersensitivity while eating. In addition, he had noticed that the shapes of his teeth appeared to be changing increasingly.

The dentist (D.E.) performed an intraoral examination, the results of which revealed severe enamel loss that had led to extensive dentin exposure in the posterior region (Figure 4A). If we assume that the enamel layer should have been at least 1 mm thick in the posterior region, a considerable reduction in the vertical dimension of occlusion (VDO) had already occurred. After eliminating the nutrition-related causes of the erosive processes, the clinician replaced all of the patient's existing restorations with resin-based composite restorations. This approach allowed the dental team to gain a clear picture of the extent of the defects, the condition of the abutment teeth and the amount of enamel remaining.

After conducting a technical (that is, evaluation of function in static and dynamic occlusion and of tooth proportions in the articulator) and clinical analysis, the dental team and the patient decided on the following treatment plan:
- fabrication of an analytic wax-up to aid the dental team in reconstruction of the esthetics and function of the dentition, as well as for the creation of a transparent, hard elastic diagnostic template (Duran, 0.5 mm, Scheu Dental, Iserlohn, Germany);
- intraoral esthetic evaluation of the wax-up with the help of the diagnostic template;
- transfer of information about the required increase in the VDO gained with the wax-up to a modified Michigan splint to enable the clinician to evaluate the functional effectiveness of the reconstruction;
- preparation of the affected teeth, starting with the opposing quadrants, using the diagnostic template as a guide and recording the maxillomandibular relationship with the aid of a Michigan splint split in half;
- insertion of the direct temporary restorations fabricated on the basis of the wax-up;
- evaluation of the clinical performance of the temporary restorations on the basis of the analytic wax-up, and any needed adjustments;
- making of impressions and prompt fabrication of final restorations in the dental laboratory;
- try-in and placement of the final all-ceramic restorations.

Treatment began with the patient's wearing a modified Michigan splint for 12 weeks. During this phase, the required increase in VDO was transferred accurately to the patient's oral cavity and was identical with the VDO increase created by the wax-up. In addition, the diagnostic template, which had been fabricated on the basis of the wax-up, enabled the patient to obtain a first impression of the treatment goal.

Figure 2. Different indications for all-ceramic restorations in the esthetic zone of the maxilla: full-crown preparations on teeth nos. 5 and 7 for zirconium oxide–based fixed dental prosthesis, circular veneer preparations for glass-ceramic restorations on central incisors; full-crown preparations for glass-ceramic restorations on teeth nos. 10 and 11.

Figure 3. Try-in of the final restorations fabricated with the IPS e.max (Ivoclar Vivadent, Amherst, N.Y.) all-ceramic system. Zirconium oxide–based three-unit fixed dental prosthesis (IPS e.max ZirCAD) to replace tooth no. 6. Circular veneers (IPS e.max Press LT framework) on central incisors and full crowns (IPS e.max Press LT framework) on teeth nos. 10 and 11. An identical veneering ceramic (IPS e.max Ceram) was used for both framework types; consequently, the esthetic appearance of the restorations is the same.

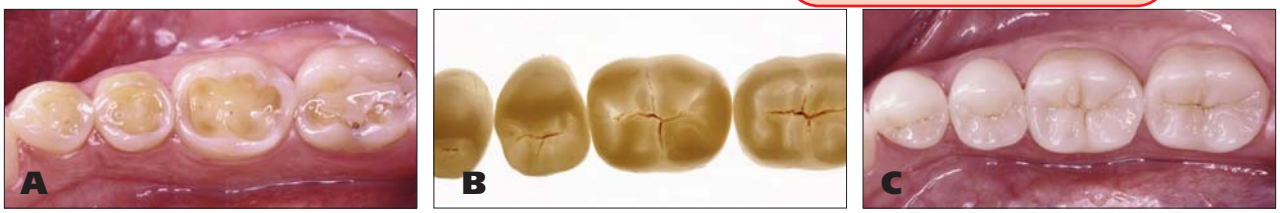

Figure 4A. Preoperative view of the combined abrasive-erosive defects on the posterior teeth on the right side of the mandible. The vertical dimension of occlusion (VDO) was affected significantly by severe loss of enamel. **B.** After fabrication of an analytic wax-up and three months' successful therapy with a modified Michigan splint for reconstruction of the VDO, onlays with a minimum thickness of 1 millimeter were fabricated (IPS e.max Press HT, Ivoclar Vivadent, Amherst, N.Y, with the staining technique). **C.** Postoperative view of the final onlays after adhesive placement with a light-curing low-viscosity resin cement (Variolink II Base, transparent, Ivoclar Vivadent). The onlays exhibited an enamellike appearance and the color adapted well to the surrounding tissues owing to a high degree of translucency.

The diagnostic template served as a guide throughout treatment and as an orientation aid during preparation of the onlays, which the clinician contoured in full anatomical shape by using a lithium disilicate glass-ceramic (IPS e.max Press, HT, with staining technique) with a minimum thickness of 1 mm (Figure 4B).[6] As a result, the dentist had to remove little tooth structure in accordance with the intended outer contours of the restorations.[7] The dentist prepared all teeth and recorded the maxillomandibular relationship at the same appointment.

The clinician fabricated the temporary restorations chairside with the help of the diagnostic template and a bisphenol A glycidyl methacrylate–based temporary restorative material (C&B Provilink, Ivoclar Vivadent [this product is no longer on the market; the authors now use Telio CS C&B, Ivoclar Vivadent). In the posterior region, the minimally retentive temporary onlays were left splinted. The clinician placed the temporary restorations with the use of a bonding agent (Heliobond, Ivoclar Vivadent) without any etching of the tooth structure.

The clinician tried in the restorations with the use of a tooth-colored glycerine gel (Try-In Paste, Variolink II) to inspect their shape and shade. He examined the marginal seal and checked the static and dynamic occlusal contacts carefully with the help of a low-viscosity silicone.

Before placing the glass-ceramic restorations, the dentist etched their inner surfaces with hydrofluoric acid (< 5 percent IPS Ceramic Etching Gel, Ivoclar Vivadent) for 20 seconds and then conditioned them with silane (Monobond-S, Ivoclar Vivadent). The clinician used the Syntac dentin adhesive system on the teeth. He placed all of the onlays by using a single light-curing luting composite (Variolink II Base, shade 110) and used a high-performance curing light (bluephase G2, with > 1,000 milliwatts per square centimeter, Ivoclar Vivadent) for the final cure. The patient's esthetic expectations were satisfied completely with reconstruction of the lost tooth structure (Figure 4C).

REHABILITATION OF DENTINOGENESIS IMPERFECTA WITH MONOLITHIC POSTERIOR CROWNS

Case 4. A 15-year-old boy visited his dentist together with his parents because he wished to have his severely discolored and malformed teeth restored. He said that he was pain free but complained about the severe social stress that he felt because of the appearance of his teeth (Figure 5). After conducting an intraoral examination and obtaining a medical history, the dentist diagnosed the patient as having type II dentinogenesis imperfecta (hereditary opalescent dentin). The specialist dental literature refers to the importance of early therapeutic intervention to stop the destruction of tooth structure and prevent the development of inadequate occlusal function.[8] Some authors have described the use of all-ceramic crowns as a possible restorative approach and have recommended adhesive cementation.[9,10] The challenge faced by the dental team in this case was the young age of the patient, who was still growing, and his request for an immediate improvement in his oral condition. In addition, the dental team had to establish an appropriate morphology of the teeth, adjust the VDO and ensure reliable retention of the restorations on the damaged tooth structure.

Against such a background, a study wax-up was created and evaluated with regard to esthetics and function. On the basis of the wax-up, the dental technician manufactured full crowns composed of high-density polymer by using CAD/CAM technology and seated them as long-term (12 months' duration) temporary restorations.

The clinician performed the final restorative procedures section by section, first in the maxilla and then in the mandible. In the anterior region, he fabricated the definitive crowns by

using a layering technique (IPS e.max Press MO 2/Ceram A2) and in the posterior region, he fabricated the full anatomical crowns by using a pressing and staining technique (IPS e.max Press, LT, A2) (Figure 6).

The prolonged temporary phase provided ample time to test the patient's new VDO, thereby enabling the treatment team to accurately predict the outcome of the final restorations.

REHABILITATION OF MISSING CENTRAL INCISORS WITH ZIRCONIUM OXIDE–BASED FIXED DENTAL PROSTHESIS

Case 5. A 45-year-old woman visited her dentist because of a trauma to the anterior maxilla. Clinical and radiographic examination revealed deep root fractures of the two maxillary central incisors. Because implants were not the treatment option of choice and all anterior teeth had been restored with metal-ceramic full crowns, the subsequent treatment consisted of preparation of the lateral incisors and canines as abutment teeth, extraction of the two central incisors and insertion of a provisional six-unit FDP, fabricated directly with the aid of a diagnostic template created according to the wax-up.

The dentist conducted conditioning for the recommended ovate pontic recipient sites with a relineable long-term provisional restoration (Figure 7A).[11] After a healing period of about 12 weeks, the clinician performed the final tooth preparations and obtained precise impressions. The design of the framework included a minimum dimension of 9 square millimeters for the connector cross-section and sufficient support of the veneering ceramic.

During try-in of the final restoration, the dental team paid special attention to ensuring the correct interaction between the ovate pontic recipient site and the FDP area of the ovate pontics. For esthetic reasons, the zirconium oxide–based framework (IPS e.max ZirCAD) in the facial cervical aspect of the abutments was reduced and shoulder veneering ceramic was applied to increase light transmission into the surrounding soft tissues and the tooth structure (Figure 7B). To stabilize the shoulder ceramic, the clinician performed selective etching with hydrofluoric acid and used an adhesive luting material (Monobond S, Multilink Automix) for the final insertion. After placement, a harmonious interaction between the soft tissue and the all-ceramic FDP was accomplished.

CONCLUSIONS

Silicate based all-ceramics have been proven effective in numerous long-term clinical studies as an appropriate material for esthetic single-tooth restorations. They are suited for a wide variety of applications, from direct layering of veneering ceramics on refractory dies to the veneering of high-strength glass-ceramic frameworks for anterior crowns or extensive veneer restorations, as well as full anatomical monolithic reconstructions without veneering for posterior inlays, onlays, partial crowns and full-

Figure 5. Preoperative view of amber-shaded posterior teeth with extended deformation caused by dentinogenesis imperfecta type II.

Figure 6. Postoperative view of monolithic full crowns (IPS e.max Press LT A2, Ivoclar Vivadent, Amherst, N.Y.) made with the staining technique and placed adhesively with a dual-curing resin cement (Variolink II, Ivoclar Vivadent) in a white opaque shade.

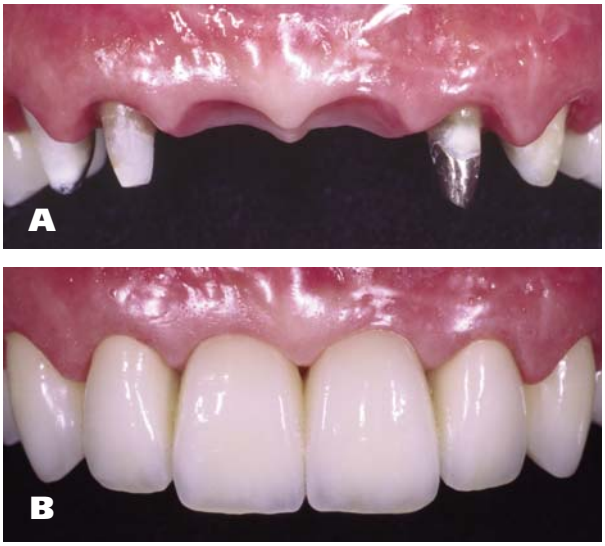

Figure 7A. Preconditioning phase of the ovate pontics recipient site in the esthetic zone of the maxilla. **B.** Six-unit zirconium oxide–based fixed denture prosthesis with ovate pontics replacing the central incisors.

crown restorations.[12-15] Veneered lithium disilicate glass-ceramic full crowns have demonstrated satisfactory long-term clinical stability in the anterior aspect, as well as in the load-bearing zone.[16,17] Given their favorable mechanical properties, lithium disilicate glass-ceramic–based restorations seem to require less invasive preparation designs as they provide a higher strength than do conventional leucite-reinforced glass ceramics.[6] Furthermore, researchers in clinical midterm (about three years) trials have reported that monolithic lithium disilicate partial-coverage restorations and full crowns offered appropriate stability and did not cause more wear in the opposing dentition than did conventional metal-ceramic crowns.[18-20]

Polycrystalline ceramics (for example, zirconium oxide) are suited for restorative components that are exposed to high loads and stress concentrations, such as all-ceramic bridge frameworks and implant abutments.[21-23] The survival rates of zirconium oxide–based FDPs (up to four units) are promising. However, significant improvement in the veneering system with regard to long-term stability is required.[14,24] Insufficient data are available regarding FDPs composed of more than four functional units. Therefore, further randomized, controlled clinical trials are needed.[24]

Our case series demonstrated that virtually all types of fixed restorations—ranging from veneers to bridges—can be accomplished with modern all-ceramic systems. From an esthetic point of view, a single veneering ceramic used for both glass- and zirconium oxide–based framework types has been proven to be advantageous. ■

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