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Rehabilitation of a patient with amelogenesis imperfecta using porcelain veneers and CAD/CAM polymer restorations: A clinical report

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The complete dental rehabilitation of patients with a vertical dimension loss (VDL) caused by structural enamel deficits associated with amelogenesis imperfecta (AI) represents a difficult challenge for restorative teams. Accurate analysis and treatment planning that includes esthetic and functional evaluations and adequate material selection are important prerequisites for successful results. Long-term provisional restorations play an important role in exploring and elucidating the patients' esthetic demands and functional needs.

Restorative treatment options can vary from requiring only oral hygiene instructions to extensive dental restorations that include composite fillings, ceramic veneers, metal-ceramic, or all-ceramic crowns. This case report describes a full-mouth rehabilitation of a patient with amelogenesis imperfecta including the case planning, bite replacement, preparation, and restoration setting steps with an experimental CAD/CAM polymer and porcelain veneers. (*Quintessence Int* 2015;46:843–852; doi: 10.3290/j.qi.a34721)

Key words: adhesive technique, amelogenesis imperfecta, CAD/CAM polymer, full-mouth rehabilitation, glass-ceramics, occlusal onlays, veneers

Amelogenesis imperfecta (AI) is a group of inherited disorders that primarily affect the human enamel.^{1,2} The level of impact may range from only a few teeth to all of the teeth in the primary or permanent dentition,³ and this condition typically causes abnormalities in the

quantity and/or quality of the enamel.⁴ AI can be expressed as an autosomal dominant or autosomal recessive genetic trait. In some isolated cases, AI may also be found in a gender-linked inheritance pattern. In general, there are four main types of AI that are classified based on the clinical and radiographic characteristics:

1. hypoplastic in which the enamel is quite well-mineralized and reduced in quantity
2. hypomaturation in which the last stages during the mineralization process are abnormal
3. hypocalcified in which the enamel is normally formed but poorly mineralized
4. hypomaturation-hypoplastic, which is a mixture of the conditions described in (1) and (2).^{3,5-7}

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Fig 1 Preoperative panoramic radiograph.



Fig 2 Preoperative view. The esthetic appearance was impaired by brown and yellow spots and generalized abrasive and erosive defects due to AI (hypomaturation).

Considering the clinical phenotypes and mode of inheritance, 15 subtypes of AI can be differentiated. The general implications of AI vary widely depending on the subtype and severity.^{2,3} The most significant patient problems associated with AI are esthetic concerns, dental sensitivity to mechanical and chemical irritations, and the loss of the vertical dimension.^{1,3} AI can additionally be associated with a wide range of other features, such as progressive root and crown resorptions, pulpal calcifications, taurodontism, malformations of roots, and congenitally missing teeth.^{1,8}

The prosthodontic treatment requirements of these patients can vary from only preventive measures, such as oral hygiene instructions, to extensive dental restorations, including composite fillings, ceramic veneers, and metal-ceramic or all-ceramic crowns. Myriad treatment options for the complete restoration of AI patients have previously been described in the literature.^{3,9,10} Restorations of such patients can prove to be a difficult but important task because such treatments need to address esthetic and functional problems. The patient's personal profile must also be considered along with the patient's socioeconomic status, the patient's age, and the type or subtype and severity of AI.³ In more extensive cases, long-term interim treatment phases are essential to test the restorative variables that can significantly influence the final restorative outcome.

Fortunately, the current demand for improved esthetic restorations has advanced the development of tooth-colored, all-ceramic systems and hybrid materials that can serve to help patients afflicted with AI.¹¹

Computer-aided design/computer-assisted manufacture (CAD/CAM) polymers, which are fabricated under high pressures and high temperatures, exhibit better mechanical properties than the traditional polymerized provisional restorations. CAD/CAM polymers can be utilized as alternatives to glass-ceramics for restorations ranging from those designed for single teeth to complex rehabilitations. The less abrasive nature and inherent color stability of these polymers relative to those of glass-ceramics provide a good treatment option for AI patients.¹²⁻¹⁸ Additionally, because CAD/CAM polymers provide increased edge stability, these restorations can be fabricated with thinner thicknesses than glass-ceramic restorations and can be considered for final non-prep restorations.^{9,19}

This clinical report documents a full-mouth rehabilitation of a patient with hypomaturation AI that utilized CAD/CAM polymer restorations and porcelain veneers.

CASE PRESENTATION

A 26-year-old woman presented to the Department of Prosthodontics of the Ludwig-Maximilians University with severe esthetic and functional problems and generalized tooth sensitivity. This patient reported no history of tetracycline ingestion by either herself as a child or her mother during pregnancy, and the patient's sister also exhibited similar signs of a mild form of AI. Following an evaluation with a specialist, it was confirmed that the patient suffered from AI.

The patient's first visit included a clinical oral examination, a complete radiographic evaluation (Fig 1), and



Figs 3a and 3b Preoperative occlusal view. All of the teeth were affected by AI (hypomaturation).



Fig 4a Preoperative view. Anterior and posterior group guidance in dynamic occlusion was obvious in both quadrants.

Fig 4b Preoperative view. Anterior and posterior group guidance in dynamic occlusion was obvious in both quadrants.

a nine-point analysis of the temporomandibular joints (a Krogh-Poulsen test). No temporomandibular disorders were noted, and all of the teeth were highly sensitive to cold and hot temperatures.

The first phase of care was palliative treatment and, most importantly, efforts were taken to relieve the pain caused by the hypersensitivities to chemical and mechanical stimuli. All defective composite fillings were removed and replaced with a nano-hybrid composite (Tetric EvoCeram, Ivoclar Vivadent). A definitive treatment plan was developed based on the following diagnostic data: an arbitrary facebow record, a centric relation (CR), study models, dynamic video recording, and intraoral (Figs 2 to 4) and extraoral photographic documentation.

The diagnostic maxillary and mandibular models were mounted in the CR utilizing a semi-adjustable articulator (Artex CR articulator, Amann Girschbacher).

An initial esthetic wax-up (EWU) was created for only the anterior region to serve as a guide for the idealized anterior tooth morphology, canine guidance, and protrusive envelope of function. The mounted and planned vertical dimension (PVD) for the posterior dentition was determined in relation to the EWU on the articulator.

The patient's PVD was validated with indirect diagnostic intraoral polymethyl methacrylate (PMMA) mock-ups that were fabricated specifically for the posterior region. These posterior mock-ups were utilized to further refine the PVD in a dynamic state in which any occlusal contact detected during speech was identified and slightly removed.

The validated PVD was 2.1 mm as measured with the canine distance of the first and fourth quadrants from the upper and lower zenith of the cervix (Fig 5).



Figs 5a and 5b The reconstructed vertical dimension was defined to be 2.1 mm for the canine distance from the upper and lower zeniths of the cements/enamel junctions (CEJs).



Fig 6 Repositioning splint fabricated according to the occlusal height of the wax-up with anterior and canine guidance in laterotrusion for a functional evaluation.



Fig 7 The repositioning splint served as a bite registration.

An occlusal splint (ie, a repositioning template) replicating the PVD was created and worn by the patient for 3 months to further confirm the appropriateness of this position (Fig 6).

During this time, the appliance was well tolerated by the patient with no complaints. The repositioning template served as a bite registration of the correct PVD, and the information was transferred to a diagnostic wax-up (DWU) (Figs 7 to 9).

The DWU was further verified via the use of full-arch indirect acrylic (PMMA) mock-ups to examine the esthetic and functional treatment objectives (Fig 10). Additional minor wax-up modifications were implemented at this time.

The DWU was then scanned with an inEos Blue scanner (Sirona), wherein the diagnostic wax-up served as a reference for the subsequent experimental CAD/

CAM polymer restorations. The experimental CAD/CAM polymer block was a prepolymerized (high temperature-cured) composite based on Tetric EvoCeram (Ivoclar Vivadent), which is a highly filled dimethacrylate composite for direct filling therapy. All of the posterior teeth from the first premolar to the second molar in each quadrant were restored with the polymer restorations. Anterior guidance was maintained through additional palatal polymer veneers for teeth 6, 7, and 11.

Minimally invasive vestibular preparations (0.5 mm) for the experimental polymer restorations were made on teeth 4, 5, 12, and 13 to correct the severe discoloration of these teeth caused by AI. If this esthetic limitation had not been present, all of the polymer restorations could have been manufactured without the need for any preparation of the teeth.



Figs 8a and 8b Transfer of the functionally evaluated vertical dimension by a separated splint on the left side (a) and a bite registration with a composite material on the right side (b).



Figs 9a and 9b Diagnostic wax-ups (DWUs) of the maxilla and mandible.



Fig 10 Indirect PMMA mock-ups according to the DWUs.

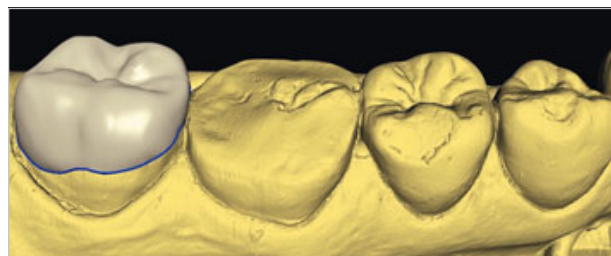


Fig 11 Construction of CAD/CAM polymer restorations using the inLAB SW 4.2 software (Sirona).

Full-arch impressions with a polyether material (Impregum Penta, 3M Espe) and a new facebow transfer were taken. The resulting stone models were again scanned with the inEos Blue scanner (Sirona), and the

data were three-point matched with the scanned wax-up data using inLAB SW 4.2 software (Sirona, Salzburg) (Fig 11).



Fig 12 CAD/CAM polymer restorations after milling and polishing.



Figs 13a and 13b CAD/CAM polymer restorations after 1 week in the oral cavity. All of the restorations were placed with the adhesive technique.

The veneer-shaped CAD/CAM polymer restorations were milled with a MC XL (Sirona) milling device and subsequently polished manually by a dental technician (Fig 12).

An esthetic try-in of the restorations was performed with glycerin gel (Liquid Strip, Ivoclar Vivadent). The restorations were then prepared for delivery with ultrasonic cleaning with distilled water for 1 minute, and the inner surfaces of the polymer restorations and all composite fillings that were inserted in the natural teeth during the pretreatment phase were airborne-particle abraded (under isolation with rubber dam) with silicoated with 30- μ m alumina particles (CoJet, 3M Espe) at a pressure of 1 bar. A silane agent (Monobond Plus, Ivoclar Vivadent) was then applied following the manufacturer's recommendations.

The teeth were conditioned with a multistep dentin adhesive (Syntac Classic, Ivoclar Vivadent) using the total-etch technique. The polymer restorations were positioned for luting with a light-curing composite (Variolink II, Base, white, Ivoclar Vivadent), and the excess composite resin was removed with an initial light polymerization exposure of 3 seconds (PolyLUX II, Kavco). The margins were then covered with an air barrier (Liquid Strip, Ivoclar Vivadent). In general, the light-curing procedure was performed for 60 seconds on three sides of the restorations. Following delivery, the final occlusal adjustments were made in both the static and dynamic positions using diamond finishing burs (143-144, 121-124, Komet) and additional polishing burs (4312A.204, Komet) (Fig 13).

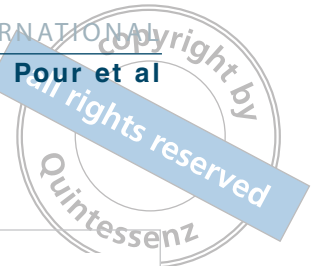


Fig 14 Preparation for the veneers with all of the proximal contact points left in place (medium wrap design).



Fig 15 Minimally invasive ceramic veneers for the restoration of the facial surfaces of the maxillary anterior teeth.



Fig 16 Try-in of the ceramic veneers with glycerin gel. All of the AI deficits were visibly masked with the restorations (the restorations clearly concealed all visible AI deficits).



Fig 17 All veneer restorations after 1 week in the oral cavity. All of the restorations were placed with the adhesive technique.



Fig 18 Postoperative smile appearance.



Fig 19 Preoperative smile appearance.

All six maxillary anterior teeth had been prepared for minimally invasive ceramic veneers (Willi Geller Creation) to meet the patient's esthetic demands and to correct the discolorations and high opacities of the tooth structures due to AI (Fig 14, and see Fig 19) after definitive insertions of all of the polymer restorations for stabilizing the vertical dimension. The restorative team decided to leave all contact points during the veneer preparation to ensure maximum tooth stability and avoid compromising the papilla isthmus (Medium Wrap Design).²⁰

The six additional maxillary ceramic veneers were etched with hydrofluoric acid (IPS Ceramic Etching

Gel, < 5%, Ivoclar Vivadent) for 90 seconds and cleaned in an ultrasonic bath with a 96% ethanol solution for 5 minutes. All restorations were preheated (Calset, AdDent), and a silane-containing coupling agent (Monobond Plus, Ivoclar Vivadent) was applied. The bonding procedure of the veneers was quite similar to that of the CAD/CAM polymer restorations with the exception of the type of luting material used (Variolink Veneer, Ivoclar Vivadent) (Figs 14 to 20). A sandwich technique (palatal composite veneers and facial ceramic veneers) was applied to the maxillary right lateral incisor and canine, and maxillary left canine.²¹⁻²³ Additionally, direct composite build-ups (Tetric EvoCe-

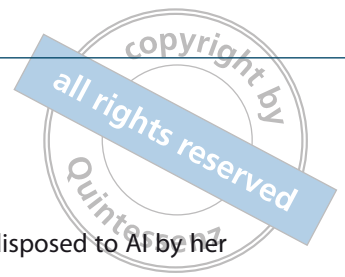


Fig 20 Postoperative profile photograph.

ram, Ivoclar Vivadent) were fabricated on the mandibular anterior teeth (central and lateral incisors) for anterior guidance.

The patient was provided preventive at-home fluoride products and oral hygiene instructions and regular dental examinations (at 6-month intervals). Finally, to protect the restorations and to ensure the long-term stability of the final results, a thin PMMA polymer guard was fabricated for nighttime use.

DISCUSSION

The significant loss of the vertical dimension exhibited by patients suffering from AI may at times require complete dental rehabilitation. Dental care practitioners should be mindful of the extended risk of caries, delayed eruption, anterior open bite, impaction of the teeth, associated gingival inflammation, and the combination of these conditions in these patients in both the primary and permanent dentitions.³

Furthermore, prior studies have shown that AI patients may exhibit increases of up to six-fold in the tendencies for the additional anomalies of impacted permanent teeth and follicular cysts.^{10,13,24} In this case study, the patient exhibited no further anomalies with the exceptions of brown and yellow spots on the tooth

structures, although she was predisposed to AI by her genetic background.

In patients with hypoplastic AI variation, there is typically sufficient enamel available for bonding restorations, such as composite resin veneers or crowns for the masking of poor esthetics. The most severe problems occur in the variants with the lowest amounts of enamel, such as the hypocalcified and the thin and smooth hypoplastic variations.¹ The hypomaturational form exhibited by the patient presented with a milder form. The teeth were discolored and exhibited brown and orange spots, but the existing tooth structure permitted favorable adhesive strength for conventional bonding techniques. Six months postoperatively, all of the restorations remained intact and were servicing the patient well. One notable study of the hypoplastic form of AI stated that the microtensile bond strength to AI enamel is lower than that to normal enamel when tested with self-etching and etch-and-rinse adhesive systems.²⁵

The potential for reduced bond strength must be considered in treatment plan objectives for these patients to ensure the selection of the most appropriate restoration.

There are a great number of restorative alternatives available for the complete rehabilitation of AI-affected enamel. These include materials that range from resin-based and metal-based to all-ceramic restorations. The selection of a new experimental high-performance CAD/CAM polymer as the material for the present patient was based on the long-term provision for the posterior teeth. This experimental CAD/CAM nanohybrid composite is composed of different additives with a high percentage of filler particles (approximately 80%). An in-vitro study investigating the tensile bond strength (TBS) values of PMMA-based CAD/CAM crowns and CAD/CAM nanohybrid composite crowns utilizing the same material used in this case produced more favorable TBS results for the CAD/CAM nanohybrid composite.²⁶

To meet the patient's esthetic demands, the maxillary anterior teeth were restored with three palatal polymer veneers and vestibular porcelain veneers



according to the technique of Vailati and Belser.²⁷⁻²⁹ The marginal fits and the color matches of all of the restorations were quite satisfactory and improved the patient's self-confidence. One of the most significant benefits of this type of therapy is the prevention of psychologic disturbances that can often be associated with the appearance of AI-affected teeth.³⁰

The predominance of the compromised vertical dimension in this AI patient presented as a result of deficits in the enamel structure and the erosive effects of exposed dentin. This effect should now be reduced due to the occlusal veneer coverage of the restored teeth. The risk associated with this complete posterior rehabilitation using the experimental CAD/CAM polymer may be that mild, renewed abrasion of the restorations and further vertical dimension loss may occur due to the lower wear resistance of this polymer compared with that of ceramics.

The reliable resin bonding between natural enamel and silicate ceramics ushered in a shift toward considerably more conservative preparation design methods relative to the preparation methods that were utilized a few decades ago.^{31,32} Minimally invasive restorations are beneficial because they reduce the risk of endodontic complications in the abutment teeth, preserve tooth structure, and offer the potential for highly pleasing esthetic results. This treatment approach offers interesting possibilities but also involves a high degree of technique sensitivity regarding the preparation (mainly in the enamel), adhesive bonding, and final fine-tuning of the static and dynamic occlusions.³³⁻³⁶ Adherence to the defined guidelines during the various clinical and technical treatment phases is a key factor for achieving long-term clinical success.³⁷ While numerous long-term clinical studies^{33,38-41} of minimally invasive restorative treatment methods with ceramic materials are available, valid clinical data are still lacking on the long-term behaviors of minimally invasive final restorations made of CAD/CAM polymers.^{42,43}

With the use of restorations made of high-performance polymers, which offer numerous excellent mechanical properties particularly in conjunction with the CAD/CAM fabrication process, veneer crowns may

be used in the restoration of the entire posterior region. If polymers are employed for the final restoration, a continuous recall program that includes marginal integrity checks and optimal oral hygiene is the main prerequisite and, with such follow-up, this technique can provide an effective restorative option for AI patients.⁹

CONCLUSION

Despite the patient's AI background, well-founded prosthetic planning procedures and clearly defined cooperation between the dentist and laboratory led to an esthetically and functionally successful treatment. A noninvasive, solely additive technique would have been possible if the patient had not exhibited such a complex tooth structure with complicated coloration.

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