

AESTHETICS



24-Karat Gold and the Art of Aesthetics

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To date, the porcelain-fused-to-metal (PFM) fixed prosthesis has lacked many of the aesthetic properties desirable in a restoration that must duplicate the appearance of a natural tooth. In addition, the PFM design often requires aggressive reduction of tooth structure in order to create enough space to accommodate a cast coping of minimal thickness and opaquer to mask the dark, unnatural color of the coping, and still have adequate space for the final porcelain layers.

The all-ceramic crown sought to correct many of these problems. However, this restorative option has its own inherent disadvantages in certain clinical situations. For example, ceramic is subject to fracture and is contraindicated in areas of heavy occlusal force.¹⁻³

To overcome these challenges and satisfy the need for a naturally appearing and highly functional tooth replacement, porcelain fused to a high-content pure gold substructure has been used. Currently, there are several systems that use pure gold for single-unit copings or fixed prosthetic frameworks. These include Goldtech Bio2000 (Argen Corp), Captek (Precious Chemicals Co) and G.E.S. (Gramm Technology). The innate properties of 24-karat cast gold provide excellent aesthetics due to the natural ability of pure gold to impart a warm, dentin-like color to the porcelain. Because of this feature, there is a complete elimination of



Figure 1. The patient before treatment. Many patients who are conscious of their poor aesthetic appearance will not smile.

gingival "black line disease" associated with traditional PFM fixed restorations. In addition, the highly biocompatible nature of pure gold is an important consideration in view of the rising incidence of those patients who are allergic to alloys that contain non-noble metals.⁴⁻⁸

In general, cast gold is an excellent choice for full-coverage restorative therapy, especially when treating patients who have compromised medical histories. This article presents a case involving a medically compromised patient where a combination of all-ceramic crowns and PFM crowns were used to restore the dentition. Empress I (Ivoclar) was selected as the material for fabricating the all-ceramic crowns, and Goldtech Bio2000, a gold alloy that uses traditional casting methods, was used for the PFM crowns. This alloy



Figure 2. A frontal view of the upper anterior teeth. Note the severe decay surrounding not only the old restorations, but the presence of new lesions as well.

satisfies the requirements necessary in a full-coverage restoration and offers excellent marginal integrity,⁹ biocompatibility, a high degree of aesthetics, and resistance to fracture by allowing for the creation of a uniform porcelain thickness. (Unpublished data. Schlessinger R.J. Cytotoxicity, Direct Contact ASTM F813-83, 1988.) (Unpublished data. Jimenez I, Sullivan RE. Direct Contact Cell Culture Cytotoxicity, Bioscreen Testing.)

CASE STUDY

The patient was a 35-year-old male with severe and rampant caries affecting much of his dentition (Figures 1 and 2). His medical history was positive for Type 2 diabetes. Interestingly, the patient reported that his teeth began to rapidly decay 1 year prior to his being diagnosed with diabetes.



Figure 3. The wax-up for the three-unit PFM bridge. Note the unique, hollow pontic specifically designed to disperse heat during the firing of porcelain, thereby preventing porcelain fracture.



Figure 4. The wax-up is cast in the 24-karat Goldtech Bio2000 alloy.

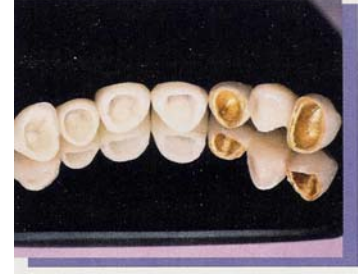


Figure 5. The PFM three-unit bridge and the all-ceramic crowns. (The crown for tooth No. 12 was not completed at this time.)



Figure 6. Each ceramic crown is individually cemented to aid in the cleanup of the resin cement.



Figure 7. Residual cured resin cement is removed with a gingival-curved, sharp-edged hand instrument. All of these steps demonstrate the complexity of bonding all-ceramic restorations.



Figure 8. The PFM crown is cemented to tooth No.12. In this case, it is difficult to distinguish between the PFM and ceramic crowns. In addition, note the healthy gingival appearance.

Because the majority of the teeth were in a compromised state, it was decided together with the patient that the maxillary teeth in the aesthetic zone would be treated first.

PREPARATION

At the preoperative appointment, a complete evaluation was performed, including the recording of a comprehensive medical dental history, intraoral and extraoral photographs, radiographs, and impressions of both arches. A comprehensive treatment plan was developed and diagnostic wax-ups were fabricated. At the following appointment, teeth Nos. 5 through 12 were anesthetized and treated. Following the removal of existing restorative material and gross caries, any remaining caries was identified using a caries staining dye (Caries Finder G, Danville Engineering) and removed. Because of its nonrestorable

nature, tooth No. 6 was extracted. In addition, because of the depth of the carious lesions, pulpal exposures were treated with root canal therapy, which included teeth Nos. 5, 7, 10, 11, and 12. Teeth Nos. 5, 7, and 12 were restored with posts and cores. All of the teeth were then prepared to receive full-coverage, fixed restorations. Teeth Nos. 8, 9, 10, and 11 would be restored with all-ceramic crowns (Empress I, Ivoclar) while teeth Nos. 5, 6, 7, and 12 would be restored with porcelain-to-gold restorations (Goldtech BiO2000). In this particular case, the decision to use all-ceramic vs PFM restorations depended primarily on the location of the margins. If the margins could be placed supragingivally, then the all-ceramic crown was chosen. If subgingival, then the PFM restoration was selected. It should be understood, however, that this gold alloy is also appropriate in cases involving supra- gingival

margins. The teeth were then temporized with a bisacryl composite (Luxatemp, Zenith Dental) and luted with a temporary cement. During the healing phase of the upper right canine extraction site, the patient was instructed in home care that included the use of fluoride trays with a prescription fluoride gel. In order to reduce the overall microbial load, promote periodontal health through tissue conditioning, and enhance connective tissue activity, a nonalcohol-based oral rinse containing essential oils and herbs (Tooth and Gum Tonic, Dental Herb Company)¹⁰ was used by the patient on a daily basis. After 3 months, the upper right temporary bridge (Nos. 5, 6, and 7) was removed and the pontic tissue appeared healthy. To create an exceptional impression and capture detailed margins, the pericoronal tissue was internally beveled using

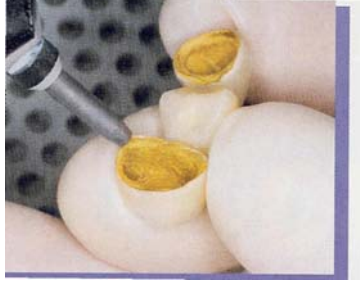


Figure 9. The inner metal surface is microetched with 50 µm aluminum oxide. Although this is not a requirement for cementation, the etching increases surface area and provides for an even stronger cement-to-metal adhesion.



Figure 10. This comparison between the PFM bridge (Nos. 5, 6, and 7) and the ceramic crowns of Nos. 8 and 9 further demonstrates the excellent aesthetics and promotion of tissue health.



Figure 11. The final result demonstrates the aesthetic beauty, biocompatibility, and easily integrated function of these restorations.



Figure 12. The satisfied patient after treatment has been completed.

a bipolar electrosurgical system (Bident International) and a final impression was then made of the prepared teeth.

LAB FABRICATION

The laboratory fabrication of the Goldtech Bio2000 alloy uses the traditional technique of the lost-wax method. For a three-unit prosthesis, the wax-up is fabricated using a unique preformed hollow wax pontic (Figure 3). This effectively reduces the otherwise large mass of gold normally found in the pontic area and allows for rapid cooling of the gold after the porcelain is fired. Without this feature, retained heat in the metal could cause the porcelain to fracture by not allowing for adequate heat dispersal (Figure 4). Following casting, porcelain is added to the framework. The fabricated all-ceramic crowns and the three-unit PFM bridge are shown in Figure 5.

CASE INSERTION

At the insertion appointment, the restorations were tried on the prepared teeth and inspected for marginal fit, interproximal contact, occlusion, and aesthetics. The aesthetics of the PFM crowns and the all-ceramic crowns were indistinguishable.

CEMENTATION OF ALL-CERAMIC RESTORATIONS

Being highly translucent, the Empress I crowns were tried in using a try-in paste (Variolink II, Ivoclar) to verify the ideal color for the resin luting cement. The PFM restorations were tried in using the customary methods for traditional crown and bridge. The teeth receiving the Empress I crowns were prepared for cementation by

mechanically micro etching them with 50 µm aluminum oxide powder (Microetcher II, Danville Engineering). This was followed by a prophylaxis using an ICB brush (Ultradent) and a slurry of pumice and water. The tooth preparations were then acid etched, isolated, and dried. A primer resin bonding agent was applied to the preparations, which were gently dried and light cured. Meanwhile, the bonding surfaces of the Empress I crowns were micro-etched with the Microetcher II unit (Danville Engineering), then rinsed, dried, and chemically etched with 9.5% hydrofluoric acid (Porcelain Etch, Ultradent). After rinsing and drying, these surfaces were cleansed of any impurities using 40% phosphoric acid (Onyx Etch, Centrix), then rinsed and thoroughly dried. A silane-coupling agent (RelyX Ceramic Primer, 3M) was applied to the luting surfaces and

dried, and a thin coating of liquid resin was applied and cured. Then a resin luting cement (Variolink II, Ivoclar) was mixed and placed into the Empress crowns. In this case, the crowns were cemented individually (Figure 6), allowing for easy cleanup, not only at the buccal and lingual, but also especially at the interproximal areas, which cannot be easily accessed with an adjacent tooth present. Excess luting cement was removed using a large microbrush (IVicrobrush, Denbur) wetted with a liquid resin (Bond It, Jeneric Pentron). Then, following complete curing of the resin cement, the remaining units were individually cemented in the same manner, and any residual cured resin cement was removed (Figure 7).

CEMENTATION OF PFM RESTORATIONS

The cementation of the PFM restorations consisted of two steps. The tooth preparation of No.12 was cleaned using the ICB brush with pumice-water slurry, then rinsed and dried, and the PFM crown was cemented using resin cement (RelyX ARC cement, 3M) (Figure 8). Then, the three-unit bridge for Nos. 5, 6, and 7 was cemented using a temporary cement (Temp Bond, Kerr) and left in this manner to observe that complete healing and non-shrinkage/ recession of the tissue at the pontic site had occurred. After several months, it was determined that the tissue at this site was dimensionally stable. The bridge was removed and the inner metal surface was microetched with 50 µm aluminum oxide at 10 to 15 psi (Figure 9). Although microetching is not a requirement prior to cementation, it does increase surface area and provide for a potentially stronger cement-to-metal adhesion. The tooth preparations of No. 5 and No. 7 were cleansed, gently dried, and the bridge restoration was thoroughly rinsed, dried, and cemented into place with RelyX ARC luting cement, which completed the restoration of the

teeth in the anterior maxillae (Figure 10).

DISCUSSION

In the past, chronic disease states that caused rampant caries and other oral disease states were dealt with in various ways. With severely carious teeth, treatment often involved tooth extraction and replacement with a removable prosthesis. Today, this treatment method would be considered a compromise for many patients. These disease states and their sequelae are now better understood, and there are many excellent treatment options that allow patients to retain their teeth and function normally, significantly enhancing their quality of life.

In the case presented, the patient reported a history of diabetes. At this point, it should be noted that there are two types of diabetes with a fairly recent change in the traditional nomenclature.¹¹ (Dr. Joseph Shulman, October 2000, personal conversation.) Insulin-dependent diabetes is currently known as Type 1 diabetes. Type 2 diabetes is the more common form of diabetes and can be controlled with the injection or oral form of insulin and/or diet. Types 1 and 2 diabetes can present with many oral manifestations. These associated conditions include, but are not limited to, dental caries, periodontal disease and degeneration, soft tissue changes, xerostomia, and an overall change in the normal oral flora with an inability or decreased ability to challenge the abnormal flora.¹²

In the past, clinical observations of diabetics indicated a pronounced susceptibility to dental caries.^{13,14} In the diabetic,

these lesions are due to a variety of factors including altered carbohydrate metabolism, xerostomia, cheilosis, reduced salivary flow, increased levels of glucose in the serous saliva of the parotid gland, and a compromised resistance to infection.⁶ In a study of 700 diabetic children, Wegener¹⁵ noted that immediately after onset of the disease, these children evidenced a higher caries incidence than controls. In a subsequent study, Wegener¹⁶ noted that in young diabetics who were placed on a reduced carbohydrate diet and treated with insulin, the frequency of caries was gradually reduced. In light of these findings, the selection of a pure gold-based alloy in the laboratory-fabricated restorations for this patient was deliberate since pure gold has the unique ability to act as a bacterial deterrent by virtue of its high surface energy and the inability of plaque to adhere to this material.¹⁷

An additional and often overlooked consideration when treating any medically compromised patient is the importance of using materials that exhibit a high degree of biocompatibility. With the widespread use of various dental alloys, clinical reports of metallic taste, xerostomia, cheilitis, and precancerous mucosal lesions such as local erosions, leukoplakia, and lichen planus, as well as sensitivity reactions, urticaria, and eczematoid skin lesions are increasing.² Syrjanen et al⁷ demonstrated the highest toxicity in high copper-containing alloy and the least reaction to gold-containing alloy. Essentially, the use of high-noble and noble alloys of single-phase microstructure can greatly minimize this biologic risk. (Unpublished data. Jimenez I, Sullivan RE. Direct Contact Cell Culture Cytotoxicity, Bioscreen Testing.)

While all of these features are desirable from a clinical perspective, the patient's perspective is often focused on comfort, function, and aesthetics. Comfort and function are essentially under the clinician's domain, whereas aesthetics are

primarily under the purview of the laboratory. The high translucency of the oxide surface of the gold alloy used in this case facilitates placement of margins less intrusive to the sulcus, for a harmonious tissue-restoration interface and invisible margins. In this case, the patient was extremely satisfied with his restored appearance (Figures 11 and 12).

Acknowledgment

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References

- 1 Drummond JL. Mechanical property evaluation of pressable restorative ceramics. *Dent Mater* 2000;16(3)226-233
- 2 Burke FJ Fracture resistance of teeth restored with dentin-bonded crowns constructed in a lucite-reinforced ceramic *Dent Mater.* 1999;15(5)359-362
- 3 van Dijken JW All-ceramic restorations classification and clinical evaluations *Compend Contin Educ Dent.* 1999;20(12) 1115-1124.
4. Kansu G Evaluation of the biocompatibility of various dental alloys part 2. allergenic potentials. *Eur J Prosth Rest Dent* 2000;4(3)155-161

- 5 Council on Dental Materials, Instruments and Equipment A report on base metal alloys for crowns and bridge application benefits and risks *J Am Dent Assoc.* 1985;111 479-483
- 6 Leinfelder KF. An evaluation of casting alloys used for restorative procedures *J Am Dent Assoc.* 1997;128(1).37-45
- 7 Syrjanen S In vitro and in vivo biological responses to some dental alloys tested separately and in combinations. *Biomaterials* 1985;61:69-176
- 8 Wataha JC Biocompatibility of dental casting alloys a review *J Prosthet Dent.* 2000;83:223-234
- 9 Small BW Esthetic and functional reconstruction of the geriatric patient *Gen Dent* 2000;Sept-Oct506- 509.
- 10 Parrett SM Microbiologically monitored periodontal therapy using an herbal and essential oil irrigant *Dent Today* 1999;18(11)118-121
- 11 American Diabetes Association Diabetes Information Available at <http://www.diabetesorglada/diabetesinfo.asp>.
- 12 Murrah VA Diabetes mellitus and associated oral manifestations a review *J Oral Pathol* 1985;14.271- 281.
- 13 Karjalainen KM Relationship between caries and level of metabolic balance in children and adolescents with insulin-dependent diabetes *Mellitus Caries Res* 1997;31:13-18
- 14 Baerger PJ Recurrent periodontal disease and caries in patients participating in a preventive dental program: the influence of disturbed carbohydrate metabolism *Ann Dent* 1974;33(2).20-30
- 15 Wegener H Dental caries in young diabetics *Caries Res.* 1971;3188-192
16. Wegener H. Dental caries in young diabetics *Caries Res* 1975;9.91-96.
- 17 Goodson M Captek alloy reduces dental plaque accumulation [abstract]. *J Dent Res.* 1999;78(special issue).138.

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