



Figures 16 and 17—The titanium metal-ceramic complex is returned to the office for bis-bake try-in.

they were positioned in the **Preciscan Laser Scanner (DCS Dental AG)**. The restoration was defined in the computer before scanning. The names of the dentist and patient, as well as the material to be CAD/CAM machined, selection of the mandibular or maxillary arch, tooth numbers, and definition of each position (crown, pontic, or natural tooth), were entered into the computer. The cover of the scanner was then closed and the dies optically measured and scanned with a high-intensity laser beam to an accurate and reproducible level of precision (300,000 points per minute at maximum resolution). The computer then took the data for each precisely measured die and matched it to the overall model, allowing the laboratory to reproduce the bridgework seamlessly and without shadows (Figures 5 through 8).

When the scanning is finished, the crown (coping) or bridge can be designed using the DCS CAD software, **Dentform™**. Each abutment is designed and calculated on the computer screen and the anatomic pontics are inserted (if bridgework is necessary). The abutments, pontics, and connectors can be adjusted for size, inclination, dimension, and positioning. Next, the cement gap is programmed into the computer to establish the proper space for cementation. The designed crown or bridge is then displayed on the computer screen and all values for margins, size, shape, and emergence profile are once again verified and stored in the computer's memory. The resulting control and stored milling data are then forwarded to the **Precimill (DCS Dental AG)** milling machine for computer machining (Figure 9).

The Precimill machining cen-

ter allows the laboratory to mill from one to 60 units of titanium per day in one fully automated operation. Currently, the machine can mill—in addition to pure titanium—other high-purity materials that include fiber-reinforced polymer, **InCeram™ Alumina**, **InCeram™ Zirconium Oxide (Vident)**, and soon the new **Cristall (DCS Dental AG)** reinforced glass ceramic (Figure 10).

The Precimill machining center is a three-axis milling unit featuring a tool changer that currently provides for 12 cutting positions and a work-piece turner. The cutting tools are primarily hard metal carbides for metal processing and diamond grinders for ceramic processing. Each tool position was monitored, corrected, replaced, and changed automatically during the milling procedure. The outer contour of the coping or framework was machined first. The automated work-piece turner then flipped the block and milled the inner surface. Proper use of the machining center can produce precise results with marginal accuracy and little to no distortion or shrinkage.

Framework Try-In

Once the titanium framework was milled and prepared by the laboratory, the framework was returned to the office for try-in evaluation (Figures 11 and 12). (This aspect of the treatment phase is not usually necessary, unless longer-span, more complicated bridgework is involved.) At this time, the provisionals were removed and the abutments cleaned. The titanium framework was seated without any interference and the marginal integrity of the abutments was clinically outstanding (Figure 13). Additionally, the weight of the titanium framework, compared to traditional pre-

cious, semiprecious, or nonprecious metal frameworks, was remarkably light. The CAD/CAM milling machine had provided an ideal thickness of the metal entirely over the prepared abutments. Placement of the provisional bridge with **TempoCem™** completed the framework try-in appointment.

Addition of Ceramics

Following the machining of the pure titanium copings and framework try-in, a unique 24-k gold bonder was fused to the titanium. This would enhance the bond strength, and its warm, deep yellow color would provide an esthetic enhancing base for the vitality and brilliance of the ceramic shade. The warmth of the underlying gold would also help to eliminate opacity and any possibility of graying at the margins (Figures 14 and 15).

Like other materials commonly used for crown and bridgework, pure titanium can also be coated with ceramic material. However, because of some of its characteristics, which differ from those of conventional metal alloys (ie, low thermal expansion coefficient), the fusing of porcelain to titanium requires a ceramic material with compatible properties. **Triceram®** titanium porcelain is a synthetic porcelain manufactured by **Dentaraum** that features a low thermal expansion coefficient with increased flexural and bond strength characteristics.⁴ A low-abrasion porcelain, **Triceram®** glass ceramic produces outstanding brilliance in color, natural shading capabilities, bond strength, and easy polishability resulting from the low-abrasion surface. Each crown was layered with body, dentin, and incisal porcelains to obtain a multilayered esthetic

result with intrinsic color and staining for maximum color stability and natural appearance.

Bis-Bake Try-in

The titanium metal-ceramic complex was again returned to the office in the bis-bake stage of porcelain application (Figures 16 and 17) and additional evaluation of the anatomical design of the applied ceramic (**Triceram® Titanium Porcelain**) and fit of the bridge were completed. Evaluation at this stage further enabled the dentist to improve the critical emergence profile in the pontic areas. The case was then returned to the laboratory for final changes, glazing, and polishing.

Delivery of a Titanium-Ceramic Bridge

The patient returned to the office 3 weeks after the preparation and impression appointment for delivery of the bridge. The bridge was examined closely on and off the model with **Orascoptic 2.6 surgical loupes (Orascoptic Research)** (Figures 18 through 20). Once anesthetized, the provisional bridge was removed and the preparations were debrided using an ultrasonic scaler. They were then scrubbed with chlorhexidine soap, rinsed, and dried. The bridge was positioned and gently pushed into place. Slight recoil of the bridge was noted, and the soft tissue in the pontic areas blanched as pressure was applied to fully seat the bridge. Slight relief of the soft tissue in this area through an electrosurgical technique (ball insert tip) enabled complete seating of the titanium-ceramic bridge. The close adaptation of the pontics to the soft tissue ridge nicely reproduced a more realistic emergence profile than did the patient's old ridge lap design bridge.

The positioned bridge was evaluated for correct occlusion and protrusive and lateral excursive movements and support. Only minor adjustments were necessary, reaffirming the importance of the try-in stages throughout this case. The ease and predictability of final delivery are often well worth the minor inconvenience of



Figures 18 through 20—The bridge is examined on and off the model and deemed ready for seating.

additional appointments for the patient, doctor, and staff.

The titanium metal-ceramic bridge was now ready for cementation. The internal aspect of the bridge was thoroughly cleaned and debrided via ultrasonic cleaning in distilled water. The bridge was then dried and set aside, and a rubber dam was placed to maintain isolation around the abutment teeth. A retraction cord was placed around each abutment tooth to create a barrier to the flow of crevicular fluid. The tooth surfaces were cleaned using the "Holy Triad" according to Bill Strupp,⁵ which included antibacterial soap, **Tubcid Red** (Global Dental Products, Inc.), and Clorox.⁵ Each tooth was scrubbed with antibacterial soap, thoroughly rinsed and dried with **Clean and Dry Air** (Clean Dry Air, Inc.), and then scrubbed and rinsed with Tubcid, dried and scrubbed with Clorox, thoroughly rinsed, and dried again. The surfaces of the teeth were then etched with 32% phosphoric acid for 15 seconds and rinsed, leaving the tooth surface moist. The **ED Primer**[®] (Kuraray America, Inc.) was then mixed and applied to each tooth surface for approximately 60 seconds. **Panavia 21**[®] (Kuraray America, Inc.) was mixed in conjunction with the application of the ED Primer[®]. The primer was lightly thinned with Clean and Dry Air. The dental assistant then loaded the abutment crowns with a uniform, thin layer of Panavia 21[®]. The bridge was placed over the abutment teeth and gently and uniformly pushed to complete seating. It was then held in place by finger pressure for 2 minutes on each of the abutments. All excess resin cement was cleaned away with



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