Metal-free alternative to PFM restoration exhibits strength and esthetics

More than forty years after their development, porcelain-fused-to-metal (PFM) restorations remain the clinical standard to which other esthetic dental materials are measured. One of the drawbacks of PFM restorations is the difficulty with making them appear lifelike when viewed adjacent to natural teeth. All-ceramic restorations have become a welcome addition to the restorative armamentarium as their lack of a metal substructure allowed them to blend well with surrounding natural dentition. Initially used as a veneering material, all-ceramic materials were pressed into service as crowns as well. The natural extension was to use these materials to replace missing teeth as well.

The search for a high-strength, esthetic, biocompatible metal-free material that could be used for multiunit frameworks as well as single unit restorations has been the focus of many research and development efforts during the last decade. Several materials have attempted to meet these needs, yet have fallen short of clinician expectations due to their low strengths and toughness. Figures 1 and 2 compare the flexural strengths and fracture toughness of some other all-ceramic materials to the recently introduced Cercon ceramic system. Zirconia’s fracture toughness and flexural strength are significantly higher than that of alumina or any other current esthetic ceramic (Fig. 3). The Cercon system offers a comprehensive solution to these needs by taking advantage of the strength, toughness, reliability, and biocompatibility of translucent zirconium oxide, along with the accuracy and control of a computer-aided manufacturing (CAM) process.

Strength Testing

A metal-free bridge that can be used anywhere in the mouth is desirable for several different patient groups. The first group is patients who report allergies to metals on their medical history. This is usually reported as allergies to various base metals as found in costume jewelry. The second group is an offshoot of the first group, and it consists of patients who are metal phobic. These patients are often the same ones who ask to have all of their silver amalgam fillings removed because of something they have heard or read. When these patients require an indirect restoration, they are usually adamant in receiving a non-metal restoration. The last group are the patients with extreme esthetic concerns. These patients tend to object to any metal, even if it is confined to a small area on a lingual surface. Even if a dentist were to design a PFM crown that had a 360-degree porcelain shoulder margin, these patients will often object if allowed to see the internal aspects of the restoration. For these groups of patients, zirconia can act as a metal substitute. Figure 4 shows a radiograph of a typical PFM bridge, while Figure 5 shows a radiograph of a Cercon zirconia bridge. Note the density of the zirconia framework and how it is essentially indistinguishable from the metal framework of the PFM bridge.

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The fracture load of Cercon zirconia is more than twice that of the other materials as seen in Figure 6. The real reliability difference is expressed at the low end of the strength distribution where most failures are expected in real life. The weakest Cercon framework is more than three times as strong as the weakest Empress 2 and InCeram frameworks. The weakest Cercon framework is also stronger than the strongest InCeram framework, and almost as strong as the strongest Empress 2 framework.

Figure 7 shows the results of a study at the University of Regensburg. The Regensburg study evaluated retained strength after fatigue, subjecting the bridges to five years of simulated oral stress and thermocycling. The results illustrate the long-term reliability of Cercon zirconia compared to the other materials. The weakest Cercon bridges in this study tested stronger than the strongest InCeram and Empress 2 bridges.

Clinical Studies

In-vivo studies began at the University of Zurich three years prior to the release of Cercon to ensure the clinical reliability and long-term viability of Cercon zirconia restorations. In the one-year recall published for this study, 21 three-unit bridges and a four-unit bridge were placed and observed. Nineteen of these bridges had a molar tooth as an abutment, while eleven of these bridges had a molar pontic. These bridges had maximum connector dimensions of 7-11mm squared, comparable to connector dimensions of PFM metal frameworks. These small connector sizes make it easier for the technician to achieve ideal esthetics, especially on anterior bridges. All of the bridges were intact at the one-year recall and a high level of patient satisfaction was reported. As of the three-year recall mark in October 2001 no damage was recorded in any of the bridges placed for this study. The study was expanded to over fifty bridges in 1999, and three-year recall data for all bridges will be available in October 2002.

Indications and Preparation Guidelines

Cercon is indicated for the fabrication of anterior and posterior single-unit crowns, and bridges with a maximum span of 38mm, which corresponds to the length of the longest Cercon blank. Typically 38mm is long enough to accommodate nearly all four-unit molar bridges as well as anterior bridges less than 38mm in length.

The Cercon preparation is accomplished in accordance with the general principles common to most all-ceramic systems. Standard all-ceramic modified shoulder margins (accomplished with burs containing the KR designation) or chamfer margins 1mm deep are both acceptable. Proximal reduction of 1.5mm is ideal, as is 1.5 to 2mm of occlusal reduction. The taper of the final preparation should be 6 to 8 degrees and undercuts are undesirable, although these can be addressed in the laboratory if necessary. One difference between the Cercon... continued on page 60
preparation and many other preparations is the preferred design of the preparation's occlusal table. Typically, the occlusal table of a preparation will mimic the pre-operative contours of the occlusal surface, resulting in an occlusal opening angle of approximately 100 degrees. The Cercon preparation should have a much flatter occlusal opening angle, preferably at least 140 degrees. Keep in mind that a preparation with a perfectly flat occlusal surface after preparation would have an occlusal opening angle of 180 degrees, whereas 140 degrees is recommended for Cercon preparations. Cercon restorations can be placed with either conventional cementation or adhesive bonding techniques. No special conditioning of the framework is needed in either case.

Clinical Case
Case 1 involves a 48-year-old male who is missing lower first and second molars (Fig. 8). The remaining third molar has good periodontal health and does not exhibit mesial tilting that commonly occurs with missing posterior teeth. The Cercon bridge will extend from the lower second premolar to the third molar. The overall length of the bridge is 37mm, just keeping it within the 38mm limit. Standard preparation was accomplished utilizing the recommended preparation guidelines of 1.5-2mm of occlusal reduction, 1.5mm of axial reduction, and a 1mm chamfer margin (Fig. 9). As a result of the light shade of the zirconia framework (Fig. 10), opaquing the framework is not the esthetic challenge that it can be with a gray metal framework. An advantage of the Cercon system is that it can be cemented or bonded with the luting material of the clinicians choice. Since the preparations in this case were near ideal, the bridge was conventionally cemented with RelyX Luting Cement (3M/ESPE). Unlike some other all-ceramic systems, the Cercon framework is strong enough to allow the clinician to adjust the occlusion prior to bonding or cementation, which allows for the ceramic surfaces to be finished and polished out of the mouth.

Bibliography

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