LAB talk

Laboratory perspectives from the inside out.

Modern Metal-Ceramic Restorations

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Metal-ceramic restorations are still the most widely used type of indirect restorative system, and have been used with great success for nearly 40 years. Porcelain remains the material of choice for the esthetic veneering of teeth, metal, or high-strength ceramic copings.[1] Porcelain has proven to be highly biocompatible, which favors a healthy gingival response. With the exception of a few truly gifted ceramists, generally only adequate esthetics have been achievable with conventional metal-ceramic restorations. This has been primarily because of the opaque dark metal oxide layers created on conventional alloys. The dark oxide can create shadowing in the adjacent soft tissue because of lack of light transmission, and the oxide can corrode and invest the surrounding tissue, creating a tattoo. The abrasiveness of the conventional feldspathic metal-ceramic porcelains against the opposing dentition has also been problematic.

Recent advances in dental materials have led to the development of new high-gold metal systems, which provide a more esthetic outcome than conventional castable metals.[2] Concomitantly, newer generation porcelains have been developed that have improved physical properties and decreased abrasion potential than conventional feldspathic ceramics. This article discusses differences and benefits of this class of materials compared with conventional metal-ceramic alloys and porcelains. With these newer metal and ceramic combinations, proper preparation, and metal framework design, it is possible to rival all-ceramic restorations in esthetic appearance. This article also gives an overview of the clinical and laboratory steps using these materials.

NEW GENERATION OF METAL-CERAMIC PORCELAINS

Research and development have led to the evolution of metal-ceramic materials that take advantage of an optimized leucite crystalline phase. In contrast to conventional metal-ceramic porcelains that have larger multi-sized and irregularly dispersed leucite crystals in the porcelain (Figure 1), the leucite crystals are more evenly dispersed and much smaller. This more homogeneous nature of the crystalline phase not only raises the coefficient of thermal expansion of the material to match that of the alloys used for copings, the absolute tensile stresses between the crystals and the glass matrix are so negligible that no tensile cracks occur (Figure 2). This homogeneous nature to the crystalline phase greatly improves the physical properties of this class of ceramic, and flexural strengths twice that of conventional metal-ceramic porcelains have been reported.[3] One long-standing concern with conventional metal-ceramic porcelains has been their abrasion potential. This is most likely a result of the rather large (30 µm) average particle size of the leucite crystals.[4] One of the main benefits of the fine crystalline structure is the decreased potential for abrasion, which can be attributed to a significantly smaller particle size of about 1 µm to 2 µm.[4] The size and shape of crystalline particles of leucite on the surface of dental ceramics appear to be the critical factor for abrasion of the opposing dentition, not the hardness of the material.

Along with the development of an optimized crystalline phase, there has been the concomitant development of lower firing materials, which allows sintering on alloys that maintain a warm gold color. High-gold alloys have the added benefit of having greatly reduced amounts of nonprecious elements that easily oxidize, creating the increased likelihood of corrosion. Corrosion products can invest the surrounding tissues causing local toxic reactions and unsightly discolorations.

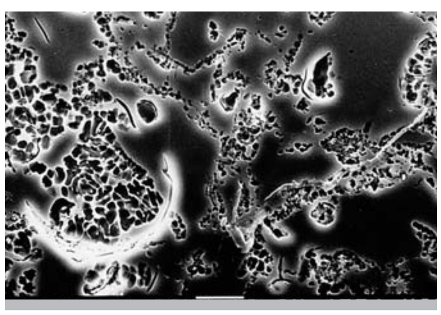

Figure 1 SEM of conventional porcelain demonstrating the large and uneven distribution of leucite crystals with tensile cracks apparent in the glass matrix. Note: this image is a 10-µm scale which is one fifth the magnification of Figure 2.

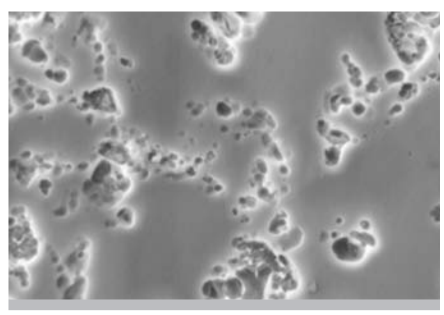

Figure 2 SEM of VM13. The average leucite crystal size of 3 µm with a more homogeneous distribution is apparent. No tensile cracking is present. Note: this is a 2-µm scale which is 5 times the magnification of Figure 1.

Figure 3 Diagram of ideal preparation for maximum esthetics for metal-ceramic restorations.

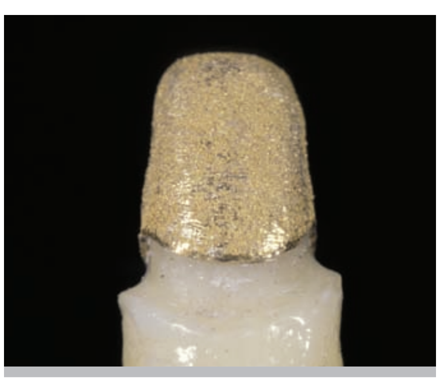

Figure 4 Captek coping demonstrating the ideal 2-mm cutback for esthetic framework design to rival all-ceramic restorations.

Figure 5 Captek with VM13 effect liner is applied at margins and a thin layer over the core.

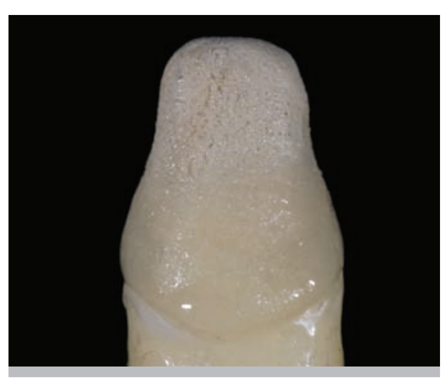

Figure 6 Fluorescent shoulder materials fired in reflected light.

Figure 7 Fluorescent shoulder materials fired in transmitted light.

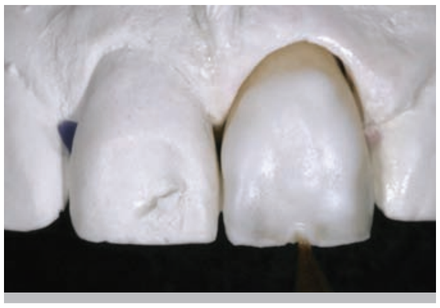

Figure 8 Porcelain built up following the skeleton build-up technique.

Figure 9 After firing of translucent materials, ready for correction, final contour-and glaze.

Figure 10 Preoperative view of patient needing gingival esthetic modifications and a new restoration on tooth No. 9.

Figure 11 Final preparation after gingival healing.

Figure 12 Captek and VM13 single crown restoration demonstrating excellent esthetics.

Figure 13 Cemented metal-ceramic units made with VM13 and Captek on teeth Nos. 18, 19, and 20.

ALTERNATE ALLOYS FOR METAL-CERAMIC RESTORATIONS

Because of the high demand for esthetics, it is desirable to use metal-ceramic restorations with a high gold content, which creates a warmer appearance to the final restoration. One recently introduced high gold alloy system, Captek™ (Precious Chemicals Company, Altamonte Springs, FL), has no nonprecious metals in the alloy, which eliminates the possibility of nonprecious metal toxicity.[2] Captek is a technology that uses advanced metallurgic principles of capillary casting technology to create metal frameworks for the subsequent veneering of porcelain. The final framework is a high gold, oxide-free alloy. This alloy is unique to dentistry in that it is a composite alloy composed of 2 distinct alloy phases. Traditional alloys used in dentistry are single-phase materials. Composite alloys can be fabricated to have better physical properties than single-phase materials.

CLINICAL TECHNIQUE

The clinical techniques for using this class of metal-ceramic materials are the same as conventional metal-ceramic systems, which can be a benefit over many of the all-ceramic systems on the market. Teeth can be prepared with any traditional margin design, but for truly esthetic metal-ceramic restorations, a shoulder preparation that allows for the creation of a 1-mm porcelain margin is preferred. Ideally, a minimum of a 270° or 360° shoulder preparation on teeth in the anterior region facilitates optimal esthetics (Figure 3). Facial reduction can be slightly less than conventional metal-ceramics as the granular gold surface of Captek gives a light scattering effect that improves the perception of depth in the restoration. Generally, an overall facial thickness of 1.2 mm to 1.3 mm gives a highly esthetic result. Accepted tissue management and impression making procedures should be followed. The author prefers polyether impression material (Impregum™, 3M™ ESPE™, Minneapolis, MN).

LABORATORY TECHNIQUE

Framework design should allow for maximum thickness of porcelain, within the accepted limits to minimize susceptibility to fracture. Frameworks can be safely thinned after casting to 0.15 mm in esthetic areas for single teeth without an increased potential for ceramic fracture.[5] Margin design can be a conventional metal margin (collar), or the metal framework can be cut back to create a porcelain butt margin. Metal-ceramic restorations can rival all-ceramic restorations in esthetics by using a vertically reduced metal framework as developed by Willi Geller. The framework is reduced up the axial wall a minimum of 2 mm (Figure 4); this allows for more translucent porcelains to be used in the marginal area, improving optics in this region. As long as the margin design is a shoulder with a 90° exit angle, this amount of cutback does not affect the strength of the cemented system.[6] After opaquing fluorescent porcelains (VM 13 Effect Liner 2 shade for brighter shades, Vident™, Brea, CA) are built up as a porcelain margin and a thin layer is also placed over the whole Captek framework and subsequently fired over (Figure 5 through Figure 7). The authors then use base dentins and opal translucents called Effect Opals with the VM13 using the skeleton build-up technique to complete the restoration (Figure 8 and Figure 9).[7] Contouring, staining, and glazing are accomplished by the same techniques as conventional metal-ceramic materials.

TRY-IN AND CEMENTATION

The crowns and/or fixed partial dentures are tried on the teeth to verify complete seating. Fit-checking medium (Fit Checker, GC, Chicago, IL) can be used to highlight binding areas, which are then adjusted. Once complete seating is obtained, the teeth are thoroughly cleaned with a slurry of pumice, or an intraoral air-abrasion unit. It is recommended to etch the porcelain margin with a gel hydrofluoric acid-etching material. This will increase the surface area, creating micromechanical retentive areas for better adhesion. Conventional or chemical cure resin cements can be used depending on clinical requirements. Experience has shown that more opaque cements like zinc phosphate limit the esthetic result with a vertically reduced metal framework. In the critical anterior areas where esthetics is paramount, more translucent cements are preferred. Rely X™ luting cement (3M/ESPE), which is in the so-called compomer class of cements, works well in posterior regions because of its ease of use. For maximum translucency the author prefers Panavia 21 TC (Kuraray America, Inc, New York, NY) or Rely X™ Unicem (3M/ESPE). Panavia 21 TC, as with all resin cements, is significantly more technique sensitive and requires the use of dentin bonding agents. The patient case in Figure 10 through Figure 12 demonstrates that even with a single central it is possible to achieve a highly esthetic restoration with modern metal-ceramic materials.

SUMMARY

Because of the short clinical history and technique difficulty of all-ceramic restorations, metal-ceramic restorations should still be considered the restoration of choice for full-coverage esthetic posterior applications (Figure 13), especially in high stress areas or for bridge applications. The ultimate esthetic dentistry takes into account biologic and long-term functional requirements. Materials and techniques that address these inseparable issues are necessary for true excellence. New metal-ceramic systems with improved optical and physical properties, coupled with esthetic designs for metal framework fabrication, can rival all-ceramic restorations in esthetic appearance. The decreased potential for abrasion and the ability to use long-established clinical and laboratory techniques make these materials an ideal choice for esthetic metal-ceramic indications. One such material has been presented for the esthetic reconstruction of teeth.

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