There are few things more contentious in dentistry today than the subject of all-ceramic restorations and their routine use as a substitute for metal. The dental consumer is increasingly demanding metal-free alternatives, yet many dental professionals still remain reluctant to commit to these materials. I remember, when I started placing all-ceramic posterior crowns in the 1980s, a few of my peers advised me against it. Well, those castable glass crowns were a disaster in my practice! But even though I replaced all of those restorations at my expense, I still felt it should not result in abandonment of the entire concept. I knew, at some point, a viable option would present itself. It began again with pressed ceramics in 1994, and in 1996 I incorporated the CEREC chairside restorative system for inlays, onlays and eventually crowns. In 2003 I began using zirconia for lab crowns and bridges, essentially converting to all ceramics with the occasional exception of some full cast gold. Today I am a vocal advocate for all-ceramic restorative dentistry.

I am sure you are no different from me in that you want to be the best you can when it comes to making your patients and yourself happy, with little to no risk for either of you. I believe the elimination of metal for many of the applications for which we have used it fits this goal. I am not here to say that amalgam, gold and the like have not served a noble purpose, but when it comes to PFMs I think we have as good, if not better, options. Dentists also like to use zirconia primarily because of its gold appearance.

Is There Really a Fracture Problem?

Nobody likes the “F” words – fracture and failure. For whatever reason, many dentists do not believe we can substitute metal with ceramics without increasing the risk of fracture or failure beyond that which we are already familiar with using PFMs. Full metal aside, any material we use in the mouth that is “white” has the potential to fracture, break, or chip, and the same is true for PFMs. There are studies nearing the 20-year mark and a preponderance of evidence well past the five-year benchmark that demonstrate more than 90 percent success for full ceramic restorations of all classes of ceramics, from CEREC CAD/CAM chairside monolithic materials to zirconia. The data shows that a small percentage of failures is part of the game, which should not be enough to deter dentists from using all ceramics, particularly if they are comfortable with PFMs.

When it comes to all-ceramics, we can fabricate to full contour with either monolithic or laminated materials. As the term implies, monolithic means compositional uniformity. Material examples include feldspars, leucite, and lithium disilicates, which are milled or machined in one piece and are bonded to tooth structure. I have used these materials successfully for years, as have many others. Laminated restorations are those with high strength cores that can be made of zirconia, alumina, or lithium disilicate. These restorations are veneered with porcelains to create translucency and a polychromatic effect, and may be cemented conventionally with resin modified glass ionomers or, in the case of certain materials, adhesively placed. Lastly, some clinicians (including myself) are now using full contour zirconia cemented to place in areas where the opaque nature of these materials cannot be seen, such as second molars, giving a white gold appearance.

Drawing from my years of experience with CEREC, I have found that the right approach lies in the correct execution of the protocol for the given application for the entire process. I do prefer chairside ceramic applications, but this is not always possible. Dentists choose zirconia primarily because of its superior mechanical properties for crowns, FPDs, implant abutments, and implant supported restorations, as it has the highest fracture toughness of all core ceramics, making it the go-to metal substitute whether for single units or long spans. This is not to say there are not other materials that will satisfy the strength criteria, but dentists are infatuated with the “strongest” ceramic material possible, and that is zirconia. Dentists also like to cement rather than bond, due to the fact that bonding is viewed as being more technique sensitive, and zirconia can be placed

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with RMGI or self-etching resin cements like the familiar PFM. When it comes to breakage, core failure is rare to non-existent with quality zirconia, but attention is being focused as of late on the phenomenon known as “chipping.”

Am I to suppose none of us has ever seen chipping occur with teeth, PFMs, pressed ceramics, and porcelain fused to alumina? Of course we have. Monolithic materials have fewer propensities to chip, though failure is abrupt – as in splitting in half. Laminated restorations, whether made with metal or zirconia cores, might show evidence of chipping ranging from microscopic to catastrophic. So let’s focus on what makes for success with zirconia, and not the other way around. While metal-based PFMs have been around for 25 years, zirconia has been used for less than 10 years, and dentists and labs cannot treat them as alike. Success begins and ends with the dentist, with the lab technician integral to the effort as well. So let’s briefly cover the five essential elements: preparation, zirconia purity/processing, fabrication, design, and occlusal dynamics.

**Proper Preparation**

Preparations for ceramics are *not* identical to those for castings, although reduction amounts are comparable with 1.5mm in fossas and fissures and 2mm over cusps, with supragingival margins possible and preferred. Preparation geometry differs substantially from a casting, which tolerates frictional fit, to a ceramic requiring passive fit. Bevels, edges and sharp angles must be eliminated with ceramics to minimize internal stress, which could lead to fracture produced by binding. Ideal preparations should be smooth, rounded, and more toward the spherical, which is counterintuitive for many of us living in the realm of metal, which is forgiving of nearly any geometry.

While rounded preparation forms seem conceptually simple, implementation is another story. In the absence of edges and angles there are no clear points of reference, making judgment of reduction difficult. Reduction must be adequate to allow for room for the zirconia core, which can be made thin but with enough room for much weaker alumina veneering porcelain of at least 1mm in thickness in load bearing areas.

**Zirconia Processing**

What zirconia system is your lab using? Is it a $49 or a $250 crown? Who is doing your lab work and how do they do it? While I am not implying quality is directly related to price, I do believe quality tends to cost more due to investments in equipment, education and time. We've heard the refrain “not all zirconia is equal,” and marketing aside, this statement is actually true. Although all zirconia is chemically similar, the final product can vary from manufacturer to manufacturer, with materials of varying density, homogeneity and crystalline conversion. This can be due to varying grain sizes of the powdered material ultimately affecting strength, with variations producing porosity and ultimately impacting long term performance. The pressing method and sintering conditions also come into play, as they too affect fit, strength, and even optical characteristics for the final restoration. Quality control will cost more, but oneredo in your office will convince you of the value, so I would stick with proven systems such as 3M ESPE Lava Zirconia.

**The Right Fabrication and Design**

When it comes to chipping in the veneered porcelain, failures occur at the cohesive interface of the veneering porcelain with the coping, along lines of lamination within the veneered material, within the laminar layer itself, and wherever porosity might exist. Avoidance of chipping starts with restoration design, and this is where some labs should be brought up to speed. Over my years of removing PFMs that failed due to porcelain fracture, I have observed that the copings were poorly designed. For example, many had unsupported porcelain under functional cusps and proximal marginal ridges. All of these failed restorations were made through a “wax and cast” technique in which the copings were “eyeballed” and cast with little attention to thickness and form. With zirconia specifically, copings should resemble dental tooth substructures in form and thickness, with the overlaid porcelain resembling enamel, much like a cross section of a human tooth exhibiting relatively even and uniform thickness of enamel over dentin. Zirconia is a “milled” material and could not exist without CAD/CAM, with the best zirconia systems utilizing “virtual design” to safeguard against poor designs using intelligent software with built-in alerts. Labs are becoming more aware, but there still exists a lag in this regard.

Anatomical design also optimizes heat transfer, permitting full vitrification of the veneering porcelain, which should be compatible with the core material in both the heating and cooling phase. While the veneering material might be layered or pressed, I recommend pressed as it is denser and easier to regulate in terms of layering. This recommendation is supported by my experience and recent studies as well. Ovens must be calibrated, ceramic loads accounted for, and cooling rates specified to assure even firing and cooling. Cooling is particularly important, as the veneering porcelain cools more rapidly than the zirconia (which is the opposite of metal). If not controlled, this rapid cooling can produce stress internally due to differing coefficients of thermal expansion.

**Occlusal Dynamics**

The design of the veneered occlusal table should accommodate the limitations of veneering materials, occlusal schematics, and preparation reduction provided. I would recommend occlusal anatomy to be secondary in anatomy at best, centering loads in fossas and over cusps rather than marginal ridges if possible. Lastly, occlusal equilibrations pre/post insertion should be performed with 40μm grit diamonds with a light touch and irri-
Embrace the Future

If you are of the opinion that all of this is too complicated to use zirconia successfully, I would counter with this – is it really that much different than a PFM in terms of what you do? The evidence supports the success of correctly fabricated zirconia restorations, and shows them to be on par with PFMs. The rate of chipping I have personally observed is less than five percent over the last seven years, which agrees favorably with many of the older PFMs I have placed. Patients like zirconia, and so do I, so I won’t be going back to PFMs. Also notable is the fact that I have used the same lab, manufacturer, and material this entire time.

One type of restoration will not fit every clinical condition and there will be instances where PFMs are warranted or should be considered, but if your choice is zirconia, choose your material process wisely, prepare the tooth correctly, communicate with your laboratory technician regarding fabrication technique, use the correct method for fixation, and balance the occlusion. While the future is hard to predict, all-ceramics are here to stay. One size does not fit all, but with the options we have in ceramics today, including monolithic and veneered, you can be metal-free if you want to be. Choice is always good, and confidence in your choice is even better!

Author’s Bio

Daniel J. Poticny, DDS, FACDNA, is one of the early innovators of all ceramic, CAD/CAM technology with the incorporation of CEREC in 1996. He is internationally recognized as one of the leading expert and educator on CAD/CAM restorative dentistry. He is a founder for the “Fully Integrated Practice,” comprised of leading educators, clinicians, and researchers on the topics of CAD/CAM applications, restorative dentistry, and cutting edge technologies for dentistry at www.fullyintegratedpractice.com. Widely published, actively involved in research and having presented worldwide, he is an advocate for digital techniques that are rapidly changing the face of the dental profession. Dr. Poticny is a graduate of the Ohio State University, the Baylor College of Dentistry and a fellow of the Academy of CAD/CAM Dentistry. He is a member of the American Dental Association, Academy of General Dentistry, the International Association for Dental Research, and the International Society of Computerized Dentistry. His practice is located in Grand Prairie, Texas.