

Tooth in a Bag: Same-Day Monolithic Zirconia Crown



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INTRODUCTION

The goal of every efficient practice is to provide the most durable restorations possible, while exceeding the minimum aesthetic needs of the patient. Newer materials and techniques make this easier than ever before.^{1,2}

Full-contour (monolithic) zirconia crowns have become popular the last few years because of their flexural strength (1,000+ MPa), tooth color, minimal wear on opposing teeth, conservative tooth preparation, and potential for excellent long-term clinical success.^{3,4}

Monolithic yttria-stabilized tetragonal polycrystalline zirconia has become very widely used the last few years because of its durability, excellent fit, and improved aesthetics (Table). Without a layering porcelain, the clinical performance has been excellent, as long as tooth preparation is adequate and the dental laboratory and clinical materials are handled in the correct manner.^{5,6} Porcelain can be pressed or stacked to the surface of zirconia to improve aesthetics but this add-on material has had a history of chipping, breakage, and delamination, resulting in compromised restorations. Whether layering porcelain to metal, lithium disilicate, or zirconia; the weak link of the restoration is the relative weak bond of the layering porcelain to the underlying substrate (coping). It is at this junction is where the potential for failure is highest.⁷⁻¹⁰ In those cases where the cosmetic demand can be met without layering porcelain, the potential exists for monolithic restorations to outperform those with aesthetic enhancing porcelain additions.^{11,12} The mantra by this clinician is to use the strongest material available that meets the minimum cosmetic need of the patient.

Because there is no layering porcelain, monolithic zirconia posterior crowns have the potential to outlast layered restorations such as the PFM because there is no porcelain to delaminate, chip, or fracture. In very aesthetically demanding situations, the practitioner must choose a material to meet the cosmetic desires of the patient. If the patient is unhappy with the appearance, it often matters not how durable the material is.



Figure 1. A patient came into the office with the distolingual cusp broken from a lower first molar.



Figure 2. The history included broken cuspal tips, parafunctional habits, and some sensitivity to bite in the newly fractured tooth No. 30.



Figure 3. Occlusion should always be a factor in both tooth preparation and material selection. In this case, the patient had a history of compliance in wearing a bite splint allowing for many restorative choices.



Figure 4. A minimal occlusal clearance of 1.0 mm is suggested. To ensure sufficient occlusal clearance, 1.5 mm depth cuts were made with a 330 carbide bur (NeoBurr No. 330 [Microcopy]), along with interproximal slices.



Figure 5. The occlusal reduction is completed with a football-shaped diamond (NeoDiamond No. 1523C [Microcopy]) and axial reduction was done with a tapered diamond bur (No. 1116.8C [Microcopy]) to a depth of at least 1.0 mm.



Figure 6. A chamfer margin (1.0 mm) was placed, even when subgingival. All line angles/corners were rounded to reduce internal restoration stresses.

Indications for Monolithic Zirconia Crowns

Dentists are often hesitant to change materials and techniques because of familiarity of their current methods, even if the success can be improved upon.^{13,14} That fear of

change is often justified particularly if there is no perceived problem with the current system or materials. New materials and techniques should be met with cautious skepticism and the balance between clinical performance, office efficiency, and scientific studies should lead our decisions for im-

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provement.¹⁵ The quest for materials with higher aesthetics or less failure, like the delamination or breakage of layering porcelain on a PFM crown, have driven us to evaluate materials like lithium disilicate and zirconia.¹⁶ With the wide variety of restorative materials today, restoration material choice lays the experience of the practitioner coupled with the prevailing dental education and research. Aesthetic materials such as pressed ceramics, PFM, and reinforced porcelains have shown varying degrees of success depending upon the clinical indications and dental team protocol.¹⁷

Gold has a long-standing functional predictability that has not been matched by any current aesthetic material. PFM crowns have dominated the dental market for many years and, despite their often cosmetic shortcomings and porcelain failures, their versatility is undeniable. Lithium disilicate is a newer material and, in its monolithic form, has proven dependable.¹⁸ So at what point would it be prudent for the clinician to consider full-contour zirconia restorations? For those patients who have compromised occlusal schemes, parafunctional habits, or a history of restoration fracture, monolithic zirconia crowns may be indicated.¹⁹ Opacity of zirconia today has lessened and overall aesthetics has certainly improved over the last few years, allowing monolithic zirconia to meet the cosmetic needs of many posterior restorations.

CASE REPORT

The patient presented with a broken cusp or fractured restoration for the third time in 3 years. Tooth No. 19 had the distobuccal cusp fractured off, with a moderately-sized composite resin restoration that was also fractured (Figure 1). There was slight pain upon biting pressure, but no signs or symptoms that indicated irreversible pulpitis. The patient had been wearing a bite splint for years to control the adverse effects of clenching (Figure 2).

The treatment plan was for a full-contour zirconia crown to address the patient's concerns about longevity of a new restoration and to also meet the aesthetic goals of the patient (Figure 3).

Tooth Preparation

For a predictable and dependable restorative outcome, proper tooth preparation that also complements the dental material selected must be



Figure 7. Occlusal clearance was checked for a minimum clearance of 1.0 to 1.5 mm. The margins were left supragingival on the facial, and were only taken 2.0 mm subgingivally as dictated by the fracture on the lingual.



Figure 10. The patient was told to close into centric occlusion and a buccal image was captured.

done.^{20,21} With monolithic zirconia, a preparation can be done with reduction very similar to that of full-gold restorations.²²⁻²⁴ A more conservative preparation can be done than for PFMs or other layered porcelain restorations because reduction need only compensate for the core.²⁴ An occlusal clearance of 1.0 to 1.5 mm of is recommended, so a 330 bur (Neo-Burr No. 330 [Microcopy]) was used to make 1.5-mm occlusal depth grooves and the interproximal slices (Figure 4) (Note: The usual length of the actual cutting portion of a 330 bur is approximately 1.5 mm, depending on the manufacturer. It is recommended that this be confirmed via measurement before using this bur in your office as a depth cutter.)

A chamfer margin with axial wall reduction of 1.0 mm is ideal for this material (Figure 5). Feather-edge margins are acceptable depending upon laboratory team's skill, but the potential for restoration over contouring and error in margin identification exist when compared to margins easily seen by whatever impression technique might be used. A preparation done with 5° to 10° taper and easily identifiable margins can make fabrication, cementation, and restorative longevity more predictable. A tapered diamond bur (NeoDiamond No. 1116.8C [Microcopy]) was used for axial reduction and margin formation in the case highlighted here (Figure 6).

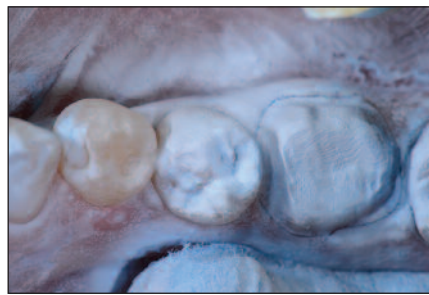


Figure 8. With the CEREC (Sirona Dental Systems) system for digital impressions, it is recommended that a reflective powder be applied for more accuracy. After application, air was blown to allow for better identification of the margins.



Figure 11. The tooth was rinsed very well and scrubbed with the cotton tip of a Dento-Infusor (Ultradent Products) syringe (containing 25% aluminum chloride gel) to ensure a clean surface and gingival sulcus for cementation.

Despite the ability of zirconia to be resin-cemented (bonded) to the tooth, the tapering of the opposing preparation walls, the surface area of the prep, and the height of the walls all are critical to long-term restoration retention and success. Zirconia bonding cannot be counted on to compensate for preparations designed with walls of excessive taper (more than 10°), or those with very short axial walls (less than 3 mm). If these parameters are not heeded, the practitioner may experience more restoration debonding/cement failures. A football-shaped diamond (NeoDiamond No. 1523C [Microcopy]) was used to complete the occlusal reduction; the reduction was then verified with the patient in centric occlusion (Figure 7).

Digital Impressions

Because zirconia crowns are CAD/CAM milled, their use is highly efficient if paired with digital impressions. The preparation and adjacent teeth were sprayed with an optically reflective powder (Figure 8), and an image was then acquired with a digital impression system (CEREC [Sirona]). The reflective powder improves image capture, particularly if tooth structure is more translucent. The opposing arch was also powdered (Figure 9) and digitally captured. Next, the patient was asked to close into "normal bite on the back teeth" (maximum intercuspation) (Figure 10), and another

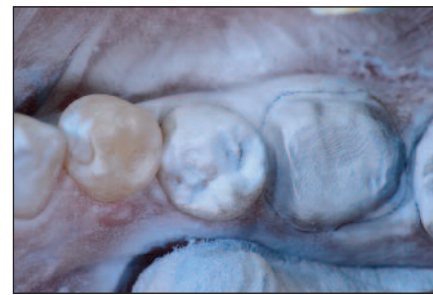


Figure 9. Likewise, the opposing arch was powdered and digitized with the CEREC AC acquisition unit.

Table.

ADVANTAGES OF MONOLITHIC ZIRCONIA CROWNS

1. Very high restoration strength
2. Adequate aesthetics in many cases
3. Conservative tooth preparation
4. Efficiently made with digital impressions
5. Can be luted with resin-based or conventional cements
6. Less time for tooth to be negatively influenced by temporary
7. May have less cost to lab and dentist

DISADVANTAGES OF MONOLITHIC ZIRCONIA CROWNS

1. Compromise in high level aesthetics
2. Difficult to remove
3. Need to polish after adjustment

digital image was captured from the buccal. After doing hundreds of restorations with this impression technique, in our hands we have had superior results with less restoration adjustments than any other indirect technique, including full-arch or quadrant trays with any of the currently popular "physical" impression materials.

Immediately after the digital images were captured, the assistant cleaned the powder off of the preparations (and opposing teeth) with an air-water spray. This was followed by scrubbing the preps with the brush tip a Dento-Infusor syringe (Ultradent Products) and (VisoStat Clear [Ultra-

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dent Products]) containing a 25% aluminum chloride gel. This technique allows for the mechanical removal of the contrasting powder and acts to wet the tooth and to reduce unwanted fluid seepage from the gingiva (Figure 11).

Provisionalization

When provisional restorations are made, care must be taken with the choice of transitional cements if dentin resin bonding is to be done during the final luting process. With various dentin bonding systems, certain cements have been shown to decrease bond strength values considerably.²⁵ For patients who are not scheduled to return the next day, a temporary may be made, but a noneugenol temporary cement is warranted because of the potential for interference of the definitive resin cement bond to the dentin.^{26,27} For only a few hours or days, the temporary is often “cemented” with a lining of Poly Vinyl wash impression material. That provides adequate short-term retention, easy cleanup, and no negative effects that the temporary cement may have on definitive cementation. For those offices that have no agreement with a dental laboratory for fast turnaround, or for less-than-dependable patients who may not return promptly, it is advisable to make a traditional provisional restoration and luted with a noneugenol temporary cement.

Digital Dentistry and Efficiency

Zirconia crowns are laboratory-fabricated CAD/CAM restorations that are made either from a digital impression or from a conventional impression that is poured up and then digitized. This latter method can introduce traditional errors into the system via inaccuracies and distortions in the impression material, nonaccurate model making, and improper die trimming. Digital impressions bypass all of these potentially error-laden steps, and increase efficiency by decreasing time, cost, and materials used.

CEREC (Sirona Dental Systems), E4D (D4D Technologies), and Lava Chairside Oral Scanner (3M ESPE) are a few of the growing number of digital systems that are being used to capture digital dental impressions. A tremendous advantage is to be able to send a digital impression over the Internet, and then have the laboratory team design the restoration, mill it, and customize it in a very short period of

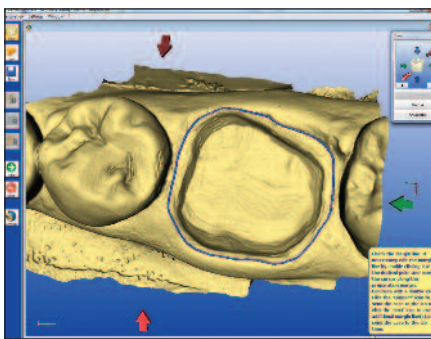


Figure 12. CEREC Connect is the software that allows the images to be sent electronically via the Internet to the lab team. First, the dental team traces the margins.

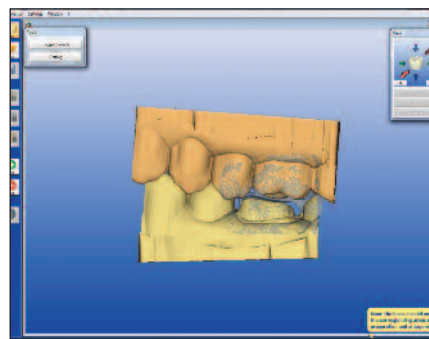


Figure 13. The digital bite was verified.

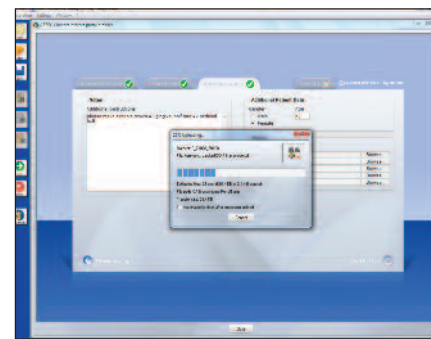


Figure 14. Within 2 minutes from digital impression capture, the images were uploaded to the lab team. Description of restoration shading was typed into the lab team's message.



Figure 15. The next morning, the monolithic zirconia restoration arrives in a jewel box in a bag. The efficiency of a lab-fabricated restoration is unsurpassed and quite an advantage to the doctor/team when milling is not done in the dental office.



Figure 16. The monolithic zirconia restoration as it arrived from the laboratory. Characterization was done, as prescribed.



Figure 17. In this case a bioactive calcium aluminate glass ionomer (Cerimir [Doxa]) was triturated and injected into the restorations.



Figure 18. The restoration placed, and the patient told to bite with firm but not heavy pressure.



Figure 19. Very easy cleanup, after about one minute. The nature of this cement allows for improved visualization of interproximal and subgingival removal over cementation with a conventional resin material.



Figure 20. The bite was checked with articulating paper at about 5 minutes; no adjustments were needed.

time. Since contacts and occlusion are done in the design software on the computer, models are not needed; and the fabrication time in the lab is less than 2 hours when no layering porcelain is done.

The chairside assistant (or the doctor) draws the margin in the software and validates the occlusion. (Figures 12 and 13). Next, the digital images are sent via the internet (CEREC Connect [Sirona Dental Systems]) to the dental laboratory team where the design is finalized and the restoration is then completed (Figure 14). *Note: A confirmation is sent that the laboratory team has received the case. In addition, the lab team is called to ensure completion of the case and to verify the time of return to the office.*

It is important to have a good relationship and to establish excellent

communication with the laboratory team. The lab team must understand how the dentist wants the nuances of the restoration to be; factors such as characterization, emergence profile, occlusal detail, and aesthetic characteristics should be worked out in advance, or explained when the case is uploaded.

Furthermore, along with a shift in philosophy for the dentist doing digital dentistry with zirconia crowns, the laboratory team must do things a bit differently as well. Total time in the laboratory (including design, custom staining, and baking) is less than 2 hours. Digital impressions and the lack of a need for stone models cut lab fabrication time down greatly, with no reason for a case to set on a shelf some-

where for 2 weeks to do a procedure that takes such little time. The “waiting” time in the lab is only for finalizing the design, cutting the sprue off after milling, application of stain if needed, and for the final firing of the case in the oven. With no models to pour, nothing to mount, no stacking or pressing of porcelain, and no polishing, the lab owner has a very limited time commitment required from his or her technician team. Even a nonlocal lab can overnight the case and have it back to the dentist in less than 48 hours. This reduces the patient's time in the provisional restoration, along with any possible time-related negative effects such as microleakage, tooth movement, and occlusion changes.

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Tooth in a Bag: “No-Modelaphobia”

It is certainly a change to receive a restoration with no models to hold! “No-modelaphobia” is hard to overcome until one trusts the system. For those who can’t go on the proverbial “model wagon,” laser-contoured models may be ordered by most labs for an additional fee (and taking several days). The negative effects of the additional time in the temporary far exceed the benefits of checking the restoration on the model.²⁸ The accuracy of the system is undeniable, as long as proper tooth preparation and accurate imaging are accomplished.²⁹⁻³¹

The next morning, the monolithic zirconia crown (BruxZir [Glidewell Laboratories]) was returned in a jewel case *in a bag* (Figure 15). About the only thing that could be examined, while in the bag, was the shade (Figure 16).

Cementation Considerations

The cementation of any restoration is either adhesive or nonadhesive. A major clinical advantage of zirconia is that it can be either conventionally cemented or resin bonded into place. The determining factor should be the resistance form of the preparation and the anticipated occlusal forces.^{32,33} When preparations are short, overly-tapered, or if occlusal forces are heavy, bonding with a resin cement is indicated. In these situations, resin cements provide maximum restoration retention, microleakage prevention, and increased fracture/fatigue resistance of the restorative material itself.^{34,35} Bonding involves more meticulous attention to detail, such as isolation, dentin preparation, and cleanup than with traditional luting materials such as a glass ionomer or zinc phosphate.

Nonadhesive cementation is a viable option if the amount of surface area and degree of divergence of the prepared walls can provide sufficient micromechanical retention. Resin reinforced glass ionomer cements like RelyX Luting (3M ESPE) or GC Fuji Plus (GC America), and newer bioactive cements such as Ceramir (Doxa) have been popular choices because of lower reported sensitivity, ease of use, and long-term clinical success on retentive preparations.^{34,36}

The most efficient cementation would be the one that bonds well to enamel, dentin, and to substrates like zirconia.³⁷ Because of the higher opac-



Figure 21. The final result (BruxZir crown [Glidewell Laboratories]). The decision to place the margins subgingivally is at the discretion of the dentist, and also based upon the cosmetic demands of the patient.

ity of most zirconia products today, there is little influence of the cement on final restoration color, as long as the margins are in a nonaesthetically critical zone.

Using a Bioactive Cement

For this case we chose to use a hybrid calcium aluminate/glass ionomer cement (Ceramir). Studies have shown that Ceramir has performed very well in clinical situations after several years with extremely low patient sensitivity.³⁸ It is intended for the definitive cementation of crowns and fixed partial dentures, gold inlays and onlays, prefabricated metal and cast dowel and cores, and all-zirconia or all-alumina crowns. The cement is a water-based composition comprising calcium aluminate and glass ionomer components, and has been demonstrated to be bioactive in that it stimulates the formation of hydroxyapatite in *in vitro* testing.³⁹

The tooth was wiped with a 2-x-2 gauze, and then the fit of the restoration was verified on the tooth. The cement was triturated (a creamy, almost mousselike consistency) and was loaded into the crown (Figure 17). After the tooth was again slightly dried with a 2-x-2 gauze, the crown was seated into place and the patient was asked to hold “slight” biting pressure on a cotton role (Figure 18). Cleanup was begun in about one to 2 minutes. Unlike the difficult cleanup often associated with bonded resin cements, this bioactive cement peels off easily in a rubbery, gellike (firm) state, making its removal easier than most other cements.

The occlusion was checked at about 5 minutes, and adjustments were done with a finishing diamond (Gold Diamond 392-018-8 F [Diatech]) in a high-speed hand piece with water and light pressure. *Note: Adjustments are rare in our office when digital impressions are used, if the lab team follows proper fabrication parameters, and if the*



Figure 22. Occlusion is always a factor in material selection, and in this case the monolithic zirconia should provide long-term function and aesthetics for this patient.

restoration is place within 48 hours. Finally, polishing was completed with a rubber porcelain polishing system (Jazz Porcelain Polishers [SS White Burs]).

As zirconium oxides are used more with time, it may be prudent to have a few burs designed for more aggressive zirconia recontouring, complete removal, or endodontic access (Great White Z Diamond burs [SS White Burs]). These diamonds come in various sizes and make gross zirconia removal much faster with less stress on the handpieces, doctor, and crown itself.

CLOSING COMMENTS

There is no doubt that speculation will exist on several levels. First, as great as the apprehension probably was for those who were encouraged to leave their copper band impressions behind when everyone went to vinyl polysiloxane quadrant impressions, there is fear of the unknown with taking the plunge into digital impressions. There is probably still an excellent clinician taking plaster impressions or using a dip tank for developing bite-wings. One should not encourage change just for change’s sake, but instead for better patient service.

Convincing a dental technician to agree to start work on a crown within hours of receiving the digital file and returning it the next day will also be a challenge for some who have the habit of sitting a case in a bin on a shelf for days before action. Without the need for layering porcelain, the fee charged by the lab may even be less because of a reduction in technician time. Some clinicians may suffer withdrawal when forced to give up their models, articulators, or pinned plaster. Even considering having a patient walk out of the office without a temporary will be outright heresy to some.

Nonlayered tooth-colored crowns, digital impressions, no models, one-

day lab fabrication, and bioactive cements may one day become the standard in dentistry. It has in this office. The rewards gained by having very accurate restorations that are extremely convenient and comfortable to the patient all while keeping the office overhead low far outweigh the stress associated with change. ♦

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Disclosure: Dr. Griffin reports no disclosures.

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