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Exploding on the CEREC® Scene 3M™ Chairside Zirconia

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Full-Mouth Implant Rehabilitation

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An Esthetic Result Using Cement-Retained Implant Restorations

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A New Chairside Zirconia for Chairside Manufacture

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Materials available to dentists incorporating CAD/CAM chairside design and manufacture have expanded greatly over the last 30 years. The success of chairside materials is known for all current materials.[1] These monolithic materials now include zirconia, which has widespread favor among patients and dentists alike. Chief reasons for this include high strength, widespread availability, low cost, and reasonably good esthetics for posterior crowns and fixed partial dentures. It can be used in a polished-only state, or characterized with external stains and glazes, and, if needed, veneered with porcelains.

While zirconia itself is not new, having been in use restoratively as an alternative to alumina since the early 2000s, what has changed is its manufacture in terms of effort, fabrication time, and very recently, improved esthetics. Formerly available solely through laboratories, availability to dentists with chairside CAD/CAM systems permits design, fabrication, and delivery within the constraints of a single appointment.

Alumina and zirconia are best described as crystalline materials void of a glass component. The presence of glass in dental porcelains provides translucency equated with a more "natural appearance" than zirconia, which will not transmit light (opaque) due to the lack of glass content. As a general statement, the higher the glass content of a dental porcelain, the better the esthetics due to increased translucency more closely mimicking natural dentition. On the other hand, the lower the glass content, the higher the strength. The tradeoffs are obvious, for patients and dentists alike.

Zirconia exists in three phases: monoclinic, tetragonal, and cubic. The first zirconia available and still in wide use today is "doped" with 3mol% yttria (3Y-TZP), which explains both its opacity and its strength depending on the percentage concentration. At room temperature, yttria stabilizes the "tetragonal" phase of the material, which contributes to the remarkable strength of zirconia in terms of its resistance to fracture (fracture toughness). This 3Y-TZP tetragonal phase zirconia responds to initial crack formation by "transformation toughening," which describes the stress at the crack tip "transforming" the smaller tetragonal crystals to "larger," "monoclinic" particles that resist further propagation of the crack.

3Y-TZP is serving the profession well as of this writing, albeit with marginal to poor esthetics by comparison to the silica glass ceramics that chairside CAD/CAM clinicians have successfully used for years.[2,3,4]

To improve esthetics, the % yttria dopant addition can be increased to produce more translucency and better optics, but with lower strength by comparison to the common 3Y-TZP iteration. The addition of more yttria will create a "partially stabilized" zirconia with both a cubic phase and tetragonal phase present. The cubic phase being essentially transparent significantly decreases the extreme scattering of light that the tetragonal phase exhibits, hence better optics. The greater the % yttria, the greater the amount of the cubic phase and the lower the percentage of the tetragonal phase. The cubic phase does not exhibit transformation toughening, which explains the resultant strength for these higher percentage formulations such as 4Y-TZP and 5Y-TZP.

With the addition of 4mol% yttria, the opacity can be diminished, or translucency improved compared to 3Y-TZP. 3M Oral Care has developed a 4Y-TZP (yttria stabilized polycrystalline-zirconia) material for chairside CAD/CAM systems with an ISO 6872:2015 Type II class 4 rating, which can be used for a posterior application involving single-unit crowns or three-unit bridges with maximum one pontic supported on each side by a crown.

Strength is a feature all dentists and patients desire to provide for a stable and long-term outcome. Can you ever have enough? Evaluation of strength by a clinician generally falls within the most commonly evaluated mechanical parameter of "flexural strength." Certainly, it has value, but while important, it tends not to correlate very well with clinical performance. However, "fracture toughness" should be considered a more reliable indicator that better correlates with clinical performance since it describes the behavior of the material to the initiation of a crack described earlier.[5] Strength is not the only factor that will influence ceramic performance, but since we as clinicians tend to be consumed by it, how can we better select materials for use intraorally that combine multiple mechanical properties?

Fortunately, by using industry-wide ISO standards, a classification system has been recently developed to help clinicians understand how we can apply mechanical properties to classify restorative materials based on application and expected outcome for a given clinical condition. Logically, by grouping dental restoratives into five classes, factoring in both flexural strength and fracture toughness and identifying clinical indications for the same, dentists should gain confidence that the material chosen will work for chosen aims and applications, assuming sound overall clinical technique (Table 1).

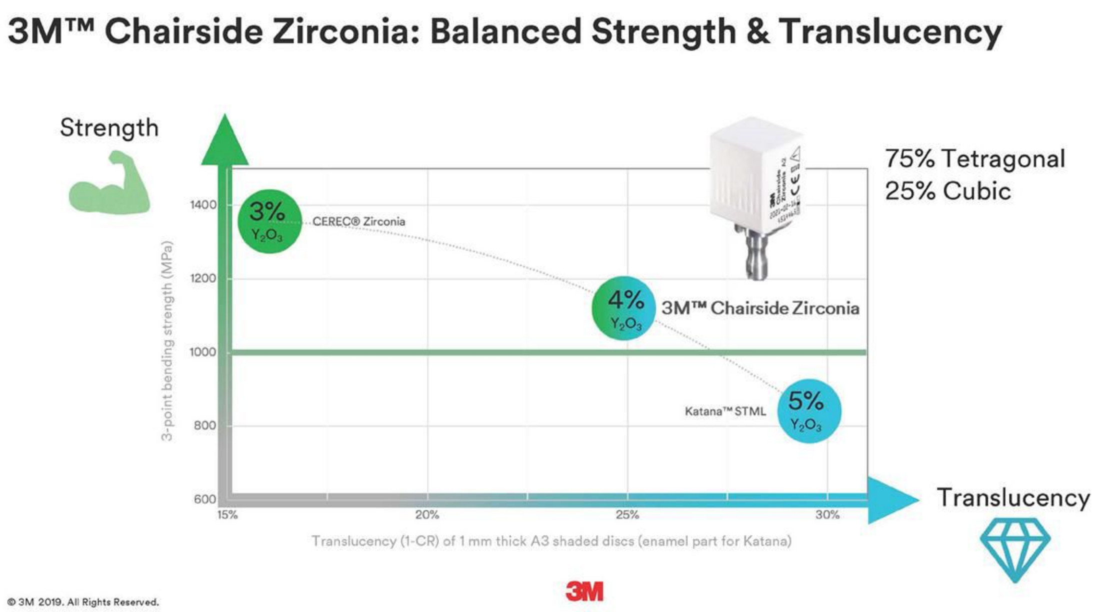

Table 1

Fig. 1: Preoperative

Fig. 2: Preoperative

What follows is a clinical example for this new material:

The patient presents with tooth #18 indicated for a full coverage crown (Figs. 1-2). Although not in the esthetic zone, the patient requests a nonmetallic alternative, for which full-contour (FCZ) 3M™ Chairside Zirconia will be used. As a class 4 material, it exhibits a flexural strength >800 MPa with a fracture toughness Klc>3.5. As a reference, a class 5 material such as 3Y-TZP would come in at >800 MPa/Klc>5.0 and a class 3 material, such as lithium disilicate, is >300 MPa/Klc>2.0.

FCZ is an excellent choice here for a variety of reasons. Arguably, esthetics is a lower priority in this location, and the patient exhibits signs of moderate to moderately severe parafunction (uncontrolled). An alternative option here would be lithium disilicate or perhaps a hybrid glass — composite material. An advantage of zirconia is its ability to function well where conservative preparations are performed or in instances where optimized strength is desired. Other factors include flexibility to cement conventionally as opposed to an adhesive approach or no need for glazed characterization.

This patient presented challenges including a substantial gag reflex and difficult access. The tooth was prepared using an Isodry (Zyris) in an intermittent fashion. By comparison to glass content ceramics requiring greater reduction for material performance, the 3M™ Chairside Zirconia has a manufacture recommended minimal thickness wall of 0.8 mm.[6] Suffice it to say, 1.0 mm is more realistic in terms of clinicians' expectations and in terms of our ability to quantify while physically preparing the tooth and allowing for any potential adjustments after fabrication and insertion. Bridge connectors require a cross-sectional area ≥12 mm^2 anterior, ≥14 mm^2 posterior. Preparation geometries are important to provide smooth, contoured surfaces creating an even and consistent cement spacer to minimize excessive intaglio overmilling. Retraction cord was used along with a retraction paste (3M Oral Care) (Fig. 3).

The CEREC® Omnicam Software V 4.6.0 (Dentsply Sirona) was used to optically scan the preparation, opposing arch, and buccal to create a virtual working model of the post-preparation condition. The restoration was designed virtually to fit the parameters of the material and the patients' existing occlusal scheme. At this point, the designed restoration is transmitted to the remote milling machine (Dentsply Sirona MCXL) (Figs. 4-5).

The designated block in shade A3 (A3.5 was a closer match but unavailable at treatment time) was inserted into the milling machine where carbide burs are used to mill the restoration. Zirconia restorations must be enlarged or overscaled to allow for shrinkage during

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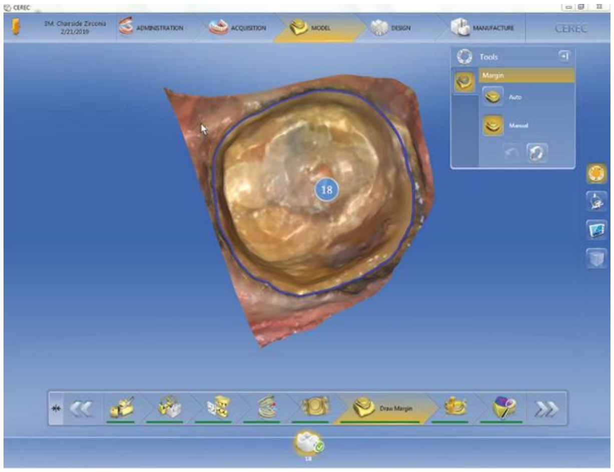

Fig. 3: Preparation and margination

Fig. 4: Proposal with occlusion

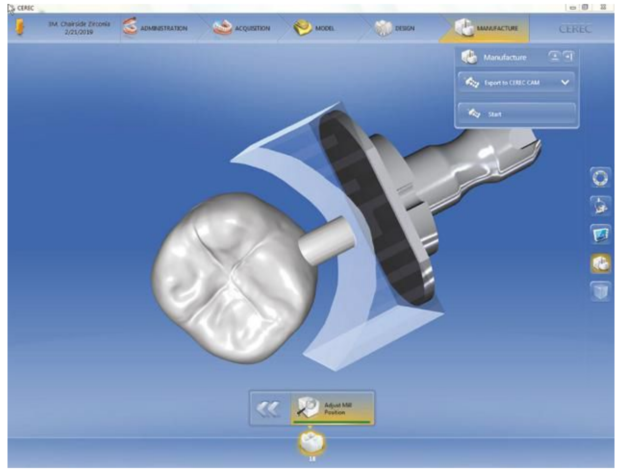

Fig. 5: Proposal with sprue

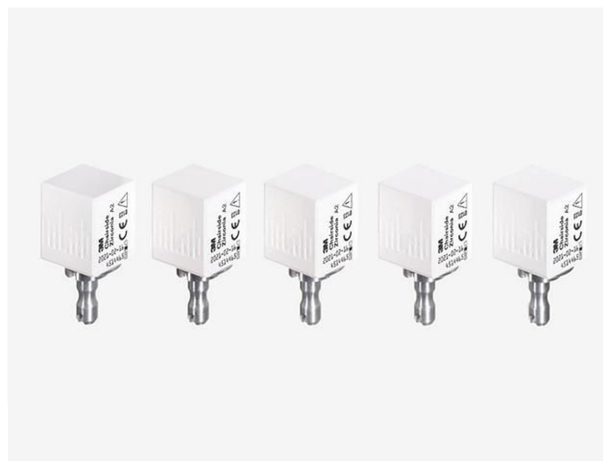

Fig. 6: 3M™ Chairside Zirconia

post-mill sintering. Each block caries a unique code to precisely allow for this, which is registered in the software. For easy shade matching, 3M™ Chairside Zirconia is available in Bleach, A1, A2, A3, A3.5, B1, C1, and D2 shades, which will fulfill 95% of patient needs. Milling can be wet or dry, with dry being the preferred option (Figs. 6-7).

Once milled, the overscaled restoration is separated from the block using a rotating diamond and with care not to engage the margin, along with smoothing if desired. Unlike other zirconia materials, dyeing agents cannot be used to influence shade, which is already built into the block.

The post-milled restoration was brushed to remove surface dust/contaminants which, if left behind, could create a spotted appearance. Subsequently, it is placed into the CEREC SpeedFire Furnace (Dentsply Sirona) for sintering, occlusal side down (Fig. 8). Sintering time is automatically calculated and ranges from 19.6 to 22.4 minutes. Once cooled, the restoration can be delivered to the patient.

Occlusal adjustments can be carried out prefinishing using a water-cooled, fine-grain diamond with grain sizes between fine 30 µm and extra-fine 15 µm at slow to moderate speed with a light touch.[7] The preferred surface for posterior zirconia is polished but glazing is possible, keeping in mind glazed surfaces are rougher than polished zirconia and will wear away with time unlike

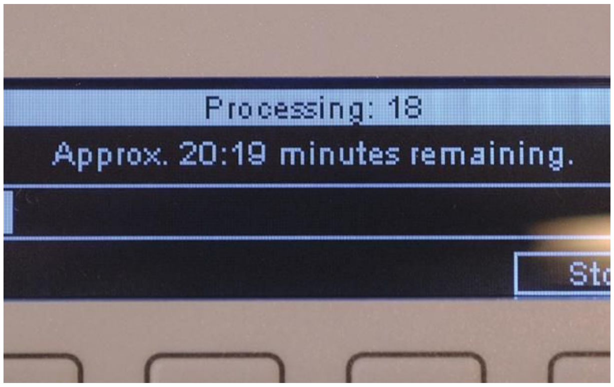

Fig. 7: Milling timeframe

Fig. 8: SpeedFire oven – occlusal down

Fig. 9: Sintered prepolish shade A3

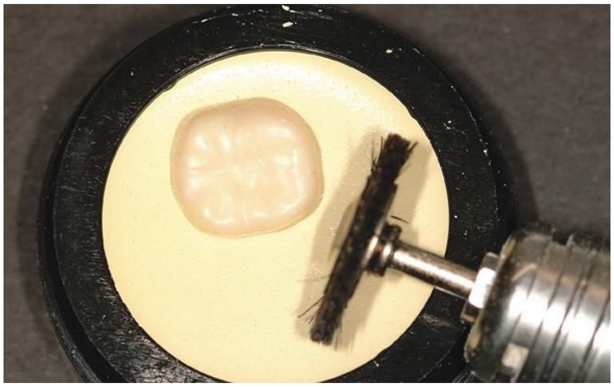

Fig. 10: Polished with DiaShine

Fig. 11: Sintered polished – note lower value

Fig. 12: 3M™ RelyX™ Unicem 2 Cement

polish. Properly polished, the wear neutral surface will be maintained indefinitely. Polishing is simple and fast using a stiff bristle brush and a diamond-impregnated polishing agent in 5 minutes or less. The overall esthetic effect is good and a significant improvement over 3Y-TZP variants (Figs. 9-12).

3M™ Chairside Zirconia can be cemented conventionally with a GIC (3M, KetacCem) or RMGI cement (3M™ RelyX™ Luting Plus)[8], self-adhesively with 3M™ RelyX™ Unicem 2 Cement, or adhesively with 3M™ RelyX™ Ultimate Cement and 3M™ Scotchbond™ Universal Adhesive.[9] Cementation choice depends on several factors, including ability to isolate, retentive capabilities of the crown preparation, and time to operate.

Fig. 13: Immediate postoperative

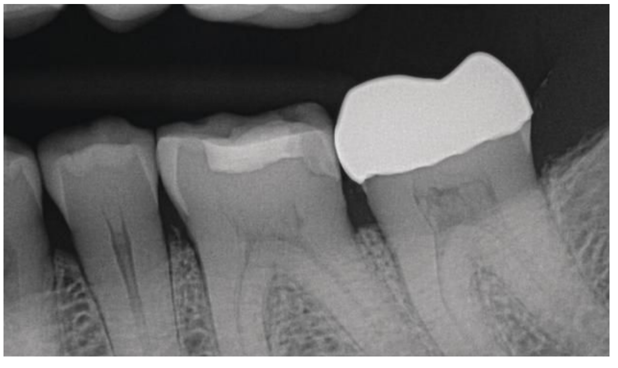

Fig. 14: Postoperative radiograph

Fig. 15: Post-cementation cleanup

In this instance, owing to lack of a distal tooth, a less-than-ideal wall taper >4-6°, and a lingual axial wall height <3 mm, a self-adhesive cement was utilized, though an RMGI cement would likely be adequate. Isolation here was a definite challenge even with an Isolite (Zyris) and cotton rolls in place.

Do not use phosphoric acid to clean these zirconia restorations. 3M™ Chairside Zirconia should be sandblasted with 2 bar 30-50 µm aluminum oxide and alcohol rinse/dry. Saliva contamination can be removed with post try-in or sodium hypochlorite 5%/water rinse/dry.

3M™ RelyX™ Unicem 2 is a dual-cure, self-adhesive cement that will create a chemical bond with the zirconia intaglio without the use of additional primers (i.e., MDP) and is to be used on the tooth surface without the use of disinfectants, desensitizers, or etchants, provided the tooth surface is clean (pumice slurry and rinse) and left in a moist state (do not desiccate), avoiding excess saliva contamination (isolation and retraction when needed) (Fig. 12).

A one-second tack cure at 5-7 mm will set 3M™ RelyX™ Unicem 2 cement to a stiff gel easily removed with a scaler. Floss the contact(s) and cure at the recommended interval of 20 seconds per tooth surface, keeping in mind light transmission will not approach that for glass ceramics but will be sufficient to maintain the restoration in place. Six minutes is required for self-curing to be realized. The immediate postoperative result is shown (Figs. 13-14).

Zirconia processing was formerly the domain of the laboratory, requiring hours to process. Newer formulations such as 3M™ Chairside Zirconia allow for convenience, long-term outcome potential, and improved esthetics.

Author's comment: This was not an ideal case and a far-from-ideal patient in terms of intraoral access for control and photography — it was a struggle! This was our first case. I am confident this material will be a valuable addition to the CEREC clinician's armamentarium. Future cases will follow.

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