



Translucent Zirconias: Tooth Reduction & Chairside Adjustment Issues

Gordon's Clinical Observations: Zirconia advertisements from many different labs are monopolizing dental publications. However, none of the promotions make clear the fact that the new translucent, esthetic zirconias have molecular structure and physical properties very different from the original zirconias used in full-strength BruxZir and for substructures. This has led clinicians to believe they can handle the new zirconias in the same way they have the lower translucent formulations of the past. The below critical **FIRST LOOK** information from a new TRAC Research controlled clinical study warns dentists and laboratory technicians to handle the new translucent zirconias differently.



Zirconia earned its reputation in the U.S. for being tough, white, and affordable with BruxZir full strength (1000+ MPa) solid zirconia restorations. Now, seven years later, new translucent zirconia formulations are being promoted heavily without informing clinicians that these zirconias are very different from the original BruxZir in strength, toughness, and ability to tolerate stress and abuse. *We are finding the new translucent zirconias require more tooth reduction, much more gentle handling during chairside adjustment, and possibly use in less stressful situations—especially when molar restorations are considered.* This report contains urgent information based on three randomized controlled clinical studies on zirconia with data at 8 months, 6 years, and 10 years. Together the three studies include over 270 practicing dentists from 36 U.S. states, 29 dental laboratories, and 18 materials (see brands studied in charts at bottom of page 3). The three studies follow the evolution of zirconia backwards in time from the present introduction of today's innovations (translucence, coloring by dipping and/or hand infiltration, and partial zirconia formulations), through the BruxZir era, back to zirconia's beginning as a substructure material. *Notably, ALL the recent innovations have produced a decrease in strength and toughness compared to full-strength BruxZir and the original substructure materials. We are just beginning to learn the indications and contra-indications for the innovations, and much is still unknown. However, it is important for clinicians to realize that the new translucence and addition of coloring have decreased zirconia's strength and resistance to stress.*

This report:

1. Summarizes what we have learned about zirconia over the past 11 years,
2. Enumerates what is still unknown,
3. Offers a few predictions and recommendations based on data from the three studies.

Future status reports will follow as more data become available.

1. What we have learned about zirconia over the past 11 years

A. Translucent, colored, and partial zirconia formulations in molar crowns at 8 months of clinical service

1. HOW TRANSLUCENCE CHANGED STRENGTH: All brands of full-strength (1000+ MPa) zirconia famously expand slightly (-2-4%) as a crack starts to form, and this expansion, plus changes in density that occur due to changes in the material's crystal structure from tetragonal to monoclinic, stop the crack. This unique characteristic is called transformation toughening. *The current changes in formulation that result in more enamel-like appearance (translucence and internal color), have not only lowered flexural strength from 1000+ to ~650 MPa, but also have all but eliminated the unique transformation toughening that gives zirconia its highly desirable toughness and resistance to fracture.*
2. After 8 months of clinical placement of seven zirconia brands (285+ molar crowns placed by 40 dentists), we have observed the following critical differences in the new translucent zirconias compared to the full-strength BruxZir:
 - More brittle (so far, 2% have broken during seating following chairside adjustments)
 - Endo access is expected to cause fracture frequently, but we do not have data on this point yet
 - Material thickness is more critical. Adherence to manufacturers' tooth preparation specifications is absolutely necessary
 - Use in molars needs careful consideration (dentists and patients should discuss what is most critical—strength and durability or esthetics)
 - Although the new esthetic zirconias are more translucent, currently, color-match is still more art than science which compromises consistency, both between technicians and at different times by the same technician
 - Like full-strength BruxZir, glaze used to preserve characterization stains is not long lasting on occlusal surfaces

3. Indications for translucent zirconias:

- For all-ceramic anterior tooth restorations

Translucent zirconias compared to e.max lithium disilicate for anterior restorations:

- Both can have appealing esthetic appearance
- Translucent zirconias have higher flexural strength at 650+ MPa vs. e.max at 350 MPa milled and ~400 MPa pressed. Clinical significance of this difference is currently unknown.
- Transformation toughening expansion to limit crack propagation and increase toughness is not an advantage for either material.
- E.max lithium disilicate has an excellent clinical-use history. Translucent zirconia is a new innovation in the process of building its history.
- Both need careful handling during chairside adjustment, and both gain strength from tooth reduction that allows greater material thickness.
- **A clear advantage of one over the other is not presently obvious. Clinical use over time will be the determinant.**

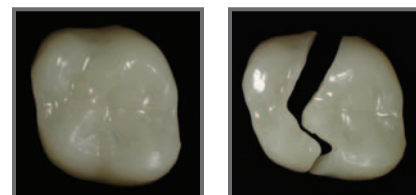


Fig 1. WARNING: Translucent zirconia can fracture at seating if substantial chairside adjustment has been performed.

Translucent Zirconias: Tooth Reduction and Chairside Adjustment Issues (Continued from page 1)

1. What we have learned about zirconia over the past 11 years (Continued)

B. Full-strength BruxZir zirconia formulation in molar crowns at 6 years of clinical service

1. Fracture at 6 years of full-strength BruxZir zirconia = 0%. The BruxZir cases received minimal tooth preparation (<1.0mm occlusal reduction with a slight chamfer margin), RMGI cementation, and subjects with bruxing/clenching habits.

2. Full-strength BruxZir zirconia molar crowns at 6 years show:

- Most durable of 118 white materials in clinical trials performed by this lab in the past 40 years
- Transformation toughening that stops cracks as demonstrated by scanning electron microscopy
- Tolerates minimal tooth preparation
- Tolerates bruxing/clenching
- No negative influence on occlusion over 6 years (no changes in muscles, joint, or local tooth mobility)
- Low biofilm retention
- Zero debonds at 6 years with simple wash/dry after try-in and RMGI cementation (*ReblyX Luting Plus; 3M*)
- Esthetics adequate, but not excellent
- Excellent biocompatibility
- Receives some wear from all types of dental materials and from enamel; receives more wear than it delivers on opposing dentition (*per measurement and monitoring of wear facets over 3 years: Christensen, RP, et al, J Dent Res Vol #93(A): #186275, 2014.*)

3. Indications for full-strength BruxZir zirconia:

- Posterior tooth restoration
- When minimal tooth preparation is desired
- Bruxing/clenching patients
- Those engaged in accident prone activities, ie: athletes
- When maximum longevity is preferred over optimal esthetics
- Multi-unit all-ceramic restorations

C. Full-strength zirconia substructures (3-unit posterior fixed partial dentures) after 10 years of clinical service

1. Substructure fracture of zirconia vs. metal at 10 years was statistically equivalent at 2% metal and 4% zirconia, but zirconia was more likely to fracture if there were clinical problems such as clinician or laboratory errors, endo required, very heavy occlusion, etc.

2. Substructure fracture of zirconia obtained from three different manufacturing facilities in 2005 was statistically equivalent, but numerically different.

- Lava (*3M ESPE, Germany*)0% fractured substructures
- Z-CAD (*Metoxit, Switzerland*).....3% fractured substructures
- Cercon (*Dentsply Prosthetics, Puerto Rico*).....13% fractured substructures

3. Metal substructures are more likely to have maximum longevity for very long spans, very heavy occlusion, or if precision attachments are desired.

4. Veneer ceramics for zirconia: of 5 tested, only CZR Press (*Kuraray Noritake*) performed well over time. Veneer ceramic problems encountered were chipping, surface crumbling, large fractures, delamination, cracking.

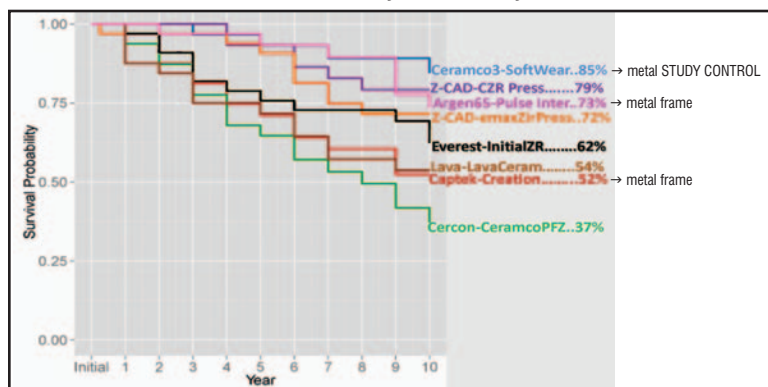
Fig. 2. Percent 3-unit posterior fixed partial dentures (FPDs) with any type veneer ceramic fracture at 10 yrs

| Veneer Ceramic Name | % FPDs with veneer ceramic fractures |
|---------------------|--------------------------------------|
| CZR Press | 27% |
| Creation | 34% |
| Pulse Interface | 38% |
| SoftWear Enamels | 53% |
| Ceramco PFZ | 56% |
| e.max ZirPress | 73% |
| Initial ZR | 91% |
| LavaCeram | 91% |

■ formulated for metal ■ formulated for zirconia

Summary of chart: CZR Press veneer ceramic had substantially fewer problems than the other brands tested, including three formulated for use over metal.

Fig. 3. Time to prosthesis replacement for 3 metal and 5 full-strength zirconia frame-veneer systems at 10 yrs



Summary of graph: Kaplan-Meier survival rates of two zirconia-based systems (*Z-CAD-CZR Press and Z-CAD-e.max ZirPress*) were statistically equivalent to the Ceramco3 metal Study Control at 10 years.

5. Indications for zirconia substructures:

- Anterior and posterior fixed prostheses
- Patients with metal allergies
- For better esthetic outcomes when labs are not as skilled with PFM esthetics
- When cost of metal is a factor

2. Critical unknowns related to ALL the new zirconia brands now flooding the market

- A. Performance compared to full-strength BruxZir
- B. Wear of opposing dentition
- C. Best cementation regimen
- D. Failure: if, when, and how
- E. How to locate the responsible source if problems occur, such as early failure or patient hypersensitivity due to widespread private labeling

Translucent Zirconias: Tooth Reduction and Chairside Adjustment Issues *(Continued from page 2)*

3. Predictions and recommendations based on data from the 3 controlled clinical TRAC Research studies

- A. Prediction:** Zirconia is here to stay for the foreseeable future. Best performing types and brands of zirconia will become apparent with clinical use.
- B. Recommendation:** Clinicians should use new brand names cautiously and be skeptical of claims that solve all challenges. When new products with minimal data are used, keep lists of who, where, and when these products are used so performance can be monitored.
- C. Recommendation:** Consider use of RMGI cement based on excellent performance in the above 3 clinical studies. BruxZir full-strength zirconia molar crowns show 0% debonds at 6 years with RMGI cement (*RelyX Luting Plus, 3M*) used by 40 different dentists. Metal and zirconia 3-unit posterior fixed partial dentures (293) each show the same 4% debond at 10 years with RMGI cement (*RelyX Luting Plus, 3M*) used by 115 different dentists. Maybe we are making zirconia cementation too complex—too many steps, too many different products.

TRAC Research Conclusions:

In the push to create translucent, colored, and partial zirconia formulations, the flexural strength and the transformation toughening unique to zirconia have been sacrificed. Clinicians are advised to: 1) avoid excessive chairside adjustments, 2) adhere to manufacturer's recommendations for preparation design, and 3) for now, use the esthetic translucent zirconias for anterior teeth. **Issues cited in this report are due to misunderstanding of differences between full-strength and current generation translucent zirconias.** Full-strength zirconias are advised for molars, bruxing/clenching patients, multi-units, and when minimal tooth preparation and/or maximum longevity are desired.

Materials in the 3 TRAC Research studies referenced in the report above

New zirconia study—now at 8 months

| Brand Name | Company | Material |
|------------------------|------------------------|---------------------------------------|
| 1. BruxZir Anterior | Glidewell Laboratories | Translucent zirconia |
| 2. BruxZirNOW | Glidewell Laboratories | Fully sintered full-strength zirconia |
| 3. CeltraDUO | Dentsply | 10% zirconia plus lithium silicate |
| 4. Cube X ² | Dental Direkt | Translucent zirconia |
| 5. Katana STML | Kuraray Noritake | Translucent zirconia |
| 6. Pavati Z40.1 | CCRI | Full-strength zirconia |
| 7. Zenostar T | Ivoclar Vivadent | Full-strength zirconia |

Full-strength BruxZir study—now at 6 years

| Brand Name | Company | Material |
|---------------|------------------------|--|
| 1. BruxZir | Glidewell Laboratories | Full-strength zirconia STUDY CONTROL |
| 2. e.max CAD | Ivoclar Vivadent | Lithium disilicate |
| 3. PressCeram | Swiss NF Metals | Veneer ceramic pressed to full-strength zirconia substructures |

3-unit posterior fixed partial denture study—now past 10 years

| Veneer Ceramic | Frame | Companies * | Material |
|--------------------------------|----------------|--------------------------|--|
| 1. CZR Press | Z-CAD | Noritake – Metoxit | Veneer ceramic pressed to full-strength Zr |
| 2. e.maxZIRPress | Z-CAD | Ivoclar – Metoxit | Veneer ceramic pressed to full-strength Zr |
| 3. CeramcoPFZ | Cercon | Dentsply Prosthetics | Veneer ceramic layered on full-strength Zr |
| 4. Initial ZR | Everest | GC – KaVo | Veneer ceramic layered on full-strength Zr |
| 5. LavaCeram | Lava | 3M ESPE | Veneer ceramic layered on full-strength Zr |
| 6. Creation | Captek | Jensen – Precious Metals | Veneer ceramic layered on metal |
| 7. Ceramco3 – SoftWear Enamels | Ultra Crown SF | Dentsply Prosthetics | Veneer ceramic layered on metal STUDY CONTROL |
| 8. Pulse Interface | Argident 65SF | Jensen – Argen | Veneer ceramic pressed to metal |

* Companies listed are those who sold the products referenced in 2005 when this study was initiated.



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3. Laboratory tests where physical and chemical properties of new products are compared to standard products.



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