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BruxZir and e.maxCAD: Superior Clinical Performance at 3+ Years

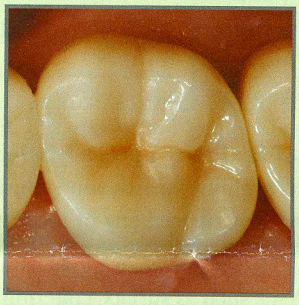
Gordon's Clinical Bottom Line: The TRAC research section of CR has been conducting a controlled clinical study of monolithic restorations for 3-1/2 years. These restorations are serving far better than anticipated. *This report contains an update on the well-documented positive TRAC Research results.*

TRAC RESEARCH

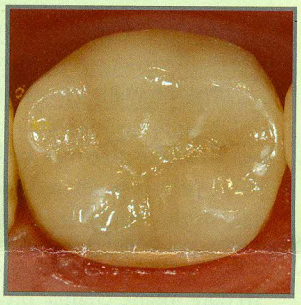
Scanning electron microscope *(SEM),* clinical, and laboratory examinations are showing ***equally excellent service for* BruxZir *and* e.maxCAD** milled full-contour crowns on molars at 41 months of service in a practice-based controlled clinical study. ***This service record exceeds that of over 100 other tooth-colored materials studied by TRAC over the past 39 years using the same methods.*** The superior performance of these two products has commanded our close attention. Literally millions of these two products have now been placed by U.S. dentists over the past five years—tipping dominance away from the time-honored PFM. Yet clinical research has lagged far behind clinical use, leaving important questions unanswered.

This report provides follow-up on the one-year data published in the June 2012 *Clinicians Report* to update clinicians as answers begin to develop to the critical clinical questions listed on page 2.

Example Cases at 3+ Years



BruxZir full-zirconia



e.maxCAD lithium disilicate

Continued on page 2

Which Cement is Best for Specific Clinical Needs?

Gordon's Clinical Bottom Line: Selection of cements for indirect restorations is extremely important to obtain optimum lack of post-operative tooth sensitivity, strength, lack of marginal breakdown, cariostatic activity, long-term service, and ability for future removal of restorations if necessary. The popularity of zirconia and lithium disilicate restorations and the introduction of several new types of cements have changed cement use. *This CR article will update you relative to the best cements for specific types of indirect restorations based on CR research and the observations of CR clinicians and Evaluators.*

The currently available and popular types of cements for indirect restorations are evident, but proper use of them remains challenging. Currently used generic names for cement types are confusing *(see October 2011 Clinicians Report).* To add to the challenge, there are several different restoration substrates and clinical needs for cementation of indirect restoration that differ one from the other. They are:

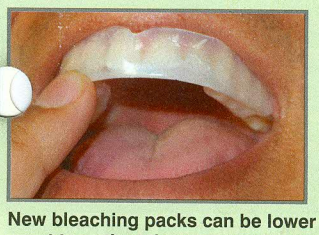
- **Full metal and porcelain-fused-to-metal crowns *(PFM),* onlays or inlays** with ***adequate*** retentive tooth preparations or with ***inadequate*** retention *(see figures on page 4)*
- **Zirconia and zirconia-based crowns** with ***adequate*** retentive tooth preparations or with ***inadequate*** retention: such as short preps or onlays
- **Lithium disilicate *(e.max)* crowns** at least 1mm thick with ***adequate*** retention or less than1mm thick and/or with ***inadequate*** retention
- **Ceramic veneers** on enamel or on both **enamel and dentin**
- **Ceramic onlays**
- **Ceramic inlays**
- **Other new or emerging tooth-colored ceramic or resin-nano ceramic restorations**

This report provides guidance on cements and cementation for each of the previous types of restorations.

Continued on page 3

Products Rated Highly by Evaluators in CR Clinical Trials

Opalescence Go: *New* time saving, cost-effective, professionally delivered, pre-loaded tooth whitening trays ***(Page 6)***

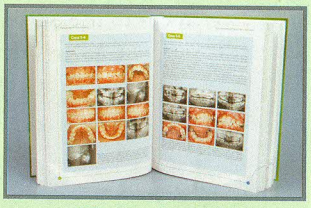


New bleaching packs can be lower cost to patient than custom trays

ZNano: *First look:* Low-price, universal resin-based composite with high initial acceptance ***(Page 6)***

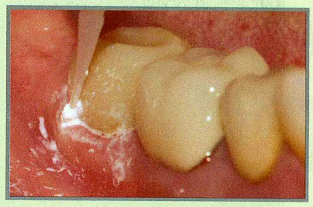
Immediately following placement of direct ZNano veneers

Early-Age Orthodontic Treatment: Excellent resource for recognizing and applying early interventions ***(Page 6)***



426-page book with excellent illustrations

Teethmate Desensitizer: Fast acting, well received bio-compatible tooth desensitizer ***(Page 6)***



Most patients report immediate relief of sensitivity

BruxZir and e.maxCAD: Superior Clinical Performance at 3+ Years *(continued from page 1)*

Critical Clinical Questions and Answers Beginning to Develop after 3+ Years of Service

1. Does BruxZir zirconia severely wear opposing dentition?

NO, see chart below. Concern that zirconia would severely wear opposing dentition dictated our locating and measuring all facets on test crowns and all types of opposing dentition. Three-year data below show **BruxZir zirconia crowns caused 23% *less* wear of opposing dentition than the pressed ceramic-over-zirconia Control *(PressCeram by Swiss NF over zirconia by Metoxit)* and about the *same* wear as e.maxCAD lithium disilicate made with an *experimental* 12.5-minute post-mill processing. BruxZir *received more wear than it caused.***

Table 1: Percent area worn by the Test Crowns and the Opposing Dentition

Brands names of materials studied	% area worn by Test Crowns on Opposing Dentition			% area worn by Opposing Dentition on Test Crowns		
	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
BruxZir	5.5 *	10.3 *	12.8 *	8.2 *	14.5 *	29.6 *
e.maxCAD *(27 min. post-mill processing)*	6.7	10.8	17.9	4.6	7.3	11.1
e.maxCAD *(12.5 min. post-mill processing)*	4.7	7.9	11.3	6.1	9.4	13.4
Pressed ceramic-over-zirconia *(Control)*	10.9	14.2	16.6	8.2	11.1	16.4

* *Data apply only to BruxZir zirconia. Other zirconia formulations may perform differently.*

2. Does BruxZir zirconia lack of flexibility adversely affect the occlusal system?

Some people predicted tooth mobility, mastication muscle strain, and joint disfunction. None of the predicted problems have been noted to date in this study. If you have experienced any of these problems with BruxZir, please contact by email rella@tracresearch.org.

3. Do full-zirconia dental restorations undergo phase change in the 100% humidity of the oral cavity?

To date, phase change problems such as surface cratering and microcracks have not been noted by SEM, nor have particles released into soft tissues with resulting inflammatory changes been seen in this study. However, more time is needed to eliminate this question. In 2001, some zirconia hip joint implants showed these changes occurring within months to beyond five years of clinical use. BruxZir was released commercially in summer 2009, so these are critical years regarding this question. Other more recently released dental zirconias will require similar long-term monitoring.

4. If e.max lithium disilicate is performing so well, why consider use of BruxZir full-zirconia?

There are no data to indicate BruxZir and e.maxCAD could not serve equally well in all *single-unit* situations. Empirically, both dentists and lab technicians have preferred to take advantage of e.max lithium disilicate's beauty for anterior teeth and BruxZir's high strength for the following:

- When minimal tooth preparation can be used.

  This study shows BruxZir meeting its claims by serving well with less than 1.0 mm occlusal reduction and near-feather edge margins on molars, even in patients with bruxing/clenching habits. e.maxCAD was not tested with minimal reduction preparations because these claims were not made for this product.

- In areas that force shallow preps due to limited space.
- For labs, anytime the preps are too shallow to allow predictable positive clinical results with other materials.

Table 2: BruxZir and e.maxCAD are the *antithesis of one another* in many characteristics.

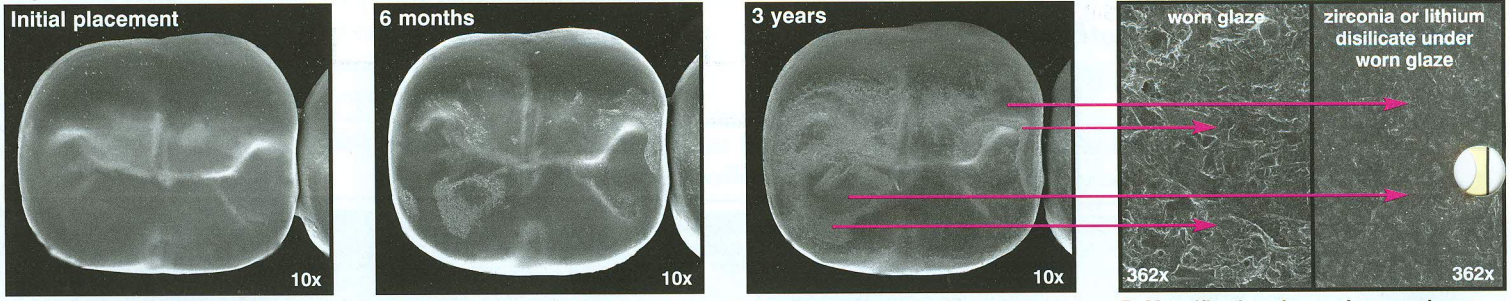
Differences		
BruxZir		e.maxCAD
• Very high flexural strength *(1000+ MPa)*	V	• Lower flexural strength *(about 350 MPa)*
• Adequate and improving esthetics	E	• Excellent esthetics
• Minimal prep permissible	R	• Deeper prep preferable
• Moderately worn by opposing dentition	S	• Moderately wears opposing dentition
• Very long post-mill processing *(8.5 hours)*	U	• Shorter post-mill processing *(12.5 to 27 min)*
• Mills smoothly at margins	S	• Milling causes many small chips at margins
• Cannot acid etch, can sandblast gently		• Acid etches well, must not sandblast

Similarities
BOTH BruxZir and e.maxCAD
• Time consuming to remove, and removal risks prep gouging
• Glaze degrades at occlusal contacts, but the unglazed materials function well in occlusion
• Currently, more time consuming for labs to polish than to glaze

5. Should BruxZir and e.maxCAD be final polished or glazed?

After only six months, it was evident the glazes would not last long. By three years, 54% of the glaze applied on occlusal surfaces in this study was no longer present *(31% removed by dentists for occlusal adjustment and 23% removed by use)*. Glaze is used because it is faster than polishing, leaves surfaces very smooth, and preserves characterization stains. However, the clinical degradation and resulting gross surface roughness negates all these points. Options are to improve the glazes or develop easy polishing techniques and internal characterization of blocks.

Figure 1: SEM documentation of glaze degradation over time for either BruxZir or e.maxCAD



A. Very smooth surface finish on glaze initially.

B. Glaze loss and roughening after only 6 months of service.

C. Severe glaze roughening and loss exposing underlying material at 3 years.

D. Magnification shows glaze roughness compared to underlying smooth material.

BruxZir and IPS e.maxCAD: Superior Clinical Performance at 3+ Years (continued from page 2)

Critical Clinical Questions and Answers Beginning to Develop after 3+ Years of Service (continued)

6. What are the best instruments for occlusal adjustment?

February 2013 *Clinicians Report* gave detailed analyses of 16 products, naming **Luster *(Meisinger)*** and **OptraFine *(Ivoclar Vivadent)*** as CR Choices.

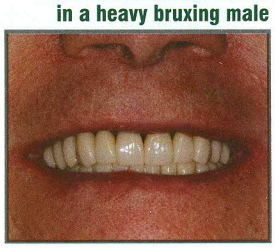
7. Is TRAC's experimental 12.5-min. post-mill processing procedure for e.max the same, better, or worse than the original 27-min. procedure?

The two procedures were statistically the same in 18 variables monitored, but crowns treated using the experimental 12.5 minute method showed numerically less wear of opposing dentition.

8. Does endo entry access compromise BruxZir and e.maxCAD restorations?

YES. October 2012 *Clinicians Report* gave detailed information on best instruments and techniques, and concluded with the necessity to ***use new diamonds, light pressure, and copious water coolant with 1mm or more of occlusal material thickness.***

Figure 2: Full-mouth restoration with BruxZir in a heavy bruxing male



9. What are the best products and techniques for removal of BruxZir and e.maxCAD crowns?

New fine-grit, round-ended taper diamonds used with water coolant, light touch, and frequent examination to avoid gouging underlying dentin works best. Additionally, Polaris Crown Cutting Wheel *(Pollard Dental Products)* is preferred by some clinicians, but requires attention during use to avoid unintended cutting.

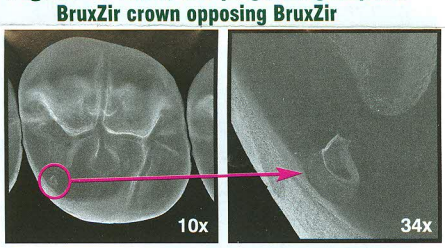
10. What is the best cementation technique for BruxZir and e.maxCAD?

See below and page 4. Steps and best products are different for zirconia vs. lithium disilicate.

11. Can zirconia have the translucency and colors available now with lithium disilicate?

Translucency and colors of zirconia are improving, but currently lithium disilicate is superior in these characteristics. However, BruxZir esthetics can be adequate *(see Figure 2, 30 full-crown BruxZir case at right).*

Figure 3: Small, non-progressing chip in a BruxZir crown opposing BruxZir



12. What is the expected service life and failure mode of BruxZir and e.maxCAD?

No one knows. The first and only chip in this study occurred on BruxZir at one year and has not progressed *(see Figure 3 at right).* More time is needed to answer this question. **Current exceptional service justifies hope for exceptional longevity.**

TRAC Conclusions:

BruxZir and **e.maxCAD** full-contour crowns on molars have demonstrated clinical service superior to all other tooth-colored materials studied clinically by TRAC over 39 years. To date, their service record resembles that of cast metal. Clinical service over three plus years has begun to answer many critical clinical questions, but important questions remain on possibility of phase change of zirconia in 100% humidity of the oral cavity, glaze use, service life, and failure mode. Status reports will be forthcoming as answers to these and other pertinent questions emerge through this study.

Which Cement is Best for Specific Clinical Needs? (continued from page 1)

Current Indirect Restoration Cement Types

Brand names are examples of categories.

1. **Resin-modified glass ionomer *(RMGI):*** strong, bonds chemically to tooth, cariostatic *(fluoride releasing),* expands and contracts similar to tooth, non-sensitive. *Examples: RelyX Luting Plus by 3M ESPE, FujiCEM 2 by GC America.*
2. **Resin with a separate self-etching primer *(self-etching):*** very strong, non-soluble, some tooth colors, bonds to tooth, fast dual cure, ***requires*** placement of separate bonding adhesive, non-cariostatic. *Examples: Panavia F2.0 by Kuraray, Multilink Automix by Ivoclar Vivadent.*
3. **Resin with incorporated self-etching primer *(self-adhesive):*** very strong, non-soluble, some tooth colors, fast dual cure, ***does not require*** placement of separate bonding adhesive, non-cariostatic. *Examples: RelyX Unicem 2 by 3M ESPE, Maxcem Elite by Kerr.*
4. **Resin used with total etch *(total-etch resin cement):*** very strong, non-soluble, many tooth colors, usually light cure, requires placement of separate bonding adhesive, can produce post-operative sensitivity if not bonded well. *Examples: Calibra by Dentsply, NX3 Nexus by Kerr, RelyX Veneer Cement by 3M ESPE, Variolink Veneer by Ivoclar Vivadent.*
5. **Conventional glass ionomer *(GI):*** strong enough for typical crown and FPD cementation, most cariostatic of cements, moderately soluble, can cause post-operative sensitivity if prep is not desensitized with glutaraldehyde, excellent for geriatric patients. *Examples: Fuji I Glass Ionomer Luting Cement by GC America, Ketac Cem by 3M ESPE.*
6. **Polycarboxylate:** adequate for typical single crown cementation, typically fails after a few years of service, bonds to tooth, non-sensitive, good intermediate term cement. *Examples: Durelon by 3M ESPE, Hy-Bond by Shofu.*
7. **Zinc phosphate *(many):*** historical success, good impact resistance, can cause post-operative tooth sensitivity, still works but not used much.

CR Survey Results *(n=1459)*

Overall percentage of time each type of cement is used:

Resin-modified glass ionomer	59%
Self-adhesive	20%
Self-etch	12%
Conventional glass ionomer	4%
Polycarboxylate	2%
Zinc phosphate	1%
GI calcium aluminate *(Ceramir)*	1%
Miscellaneous	1%

Most important characteristics wanted in cement *(could indicate two):*

Lack of post-operative sensitivity	61%
Strength	55%
Bond to tooth	37%
Low solubility	18%
Cariostatic properties	15%
Low film thickness	9%
Expansion and contraction similar to tooth	4%

How often do crowns come loose from abutments?

0–5% of the time	90%
6–10% of the time	8%
11–15% of the time	2%
16% or more of the time	0%

How often do you have post-operative tooth sensitivity?

0–5% of the time	78%
6–10% of the time	17%
11–15% of the time	3%
16% or more of the time	1%

How often do you see caries on margins of crowns or fixed prostheses after five years of service?

0–5% of the time	50%
6–10% of the time	33%
11–15% of the time	12%
16–20% of the time	3%
21% or more of the time	1%

Which Cement is Best for Specific Clinical Needs? (continued from page 1)

Cementation Steps for Specific Restoration Needs	Metal or PFM		Zirconia or zirconia-base crown, inlay, onlay		Lithium disilicate * crown, inlay, onlay		Ceramic veneer on enamel (non-zirconia)
	Adequate retention	Low retention	Adequate retention	Low retention	Adequate retention	Low retention	
Try on restoration	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Roughen restoration internal with diamond	No	Yes	No, microcracks	No, microcracks	No, microcracks	No, microcracks	No, microcracks
Sandblast restoration internal	Yes	Yes	Yes, or Ivoclean	Yes, or Ivoclean	No, microcracks	No, microcracks	No, microcracks
Clean restoration internal with phosphoric acid, wash, dry	Elective	Elective	No, contam-inates	No, contam-inates	Yes	Yes	Yes
Wash and dry	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zirconia primer	No	No	No	Yes	No	No	No
Silane on restoration	No	No	No	No	Yes	Yes	Yes
Roughen prep with diamond	No	Yes	No	Yes	No	Yes	No
Clean prep with pumice flour	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Glutaraldehyde/HEMA, suction prep	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Seat with RMGI or GI	Yes	No, or infrequent	Yes	No, or infrequent	Yes, if crown	No	No
Seat with resin	Elective	Yes	Elective	Yes	Yes, if inlay or onlay	Yes	Yes

* *Assume lab has hydrofluoric acid etched*

Clinical Tips in Cementation

See cement types on page 3.

A. Resin-modified glass ionomer cements are most popular and, at this time, best meet the needs for most crown and FPD cementations requiring moderate strength and cariostatic activity.

B. Patient caries preventive need should be considered when selecting cement. Where indicated, consider fluoride containing cements for patients over 50 years of age or with poor oral hygiene *(RMGI or GI).*

C. Some *resin* cements contain fluoride. However, release is minimal and usually exhausted soon after cementation.

D. Tooth preparations with low retention require different cementation procedures than preps with adequate retention. Preps measuring at least 4mm from the apical margins to the occlusal/incisal table and having only up to 20° of non-parallelism are generally considered to have adequate mechanical retention *(see photos below).* Most onlays have low mechanical retention.

E. Resin cements are recommended for preps with low mechanical retention as described in the table above.

F. Resin-modified glass ionomer cements are recommended for preps with adequate restorative material thickness *(at least 1mm on axial walls for IPS e.max, 0.6mm for zirconia)* and mechanical retention because of their cariostatic properties and easier removal than when resin cement is used.

G. Self-etch resin cements are well proven, but self-adhesive cements have similar strength and are now more popular because they are easier to use.

H. Self-adhesive cements are rapidly becoming the most popular form of resin cement due to their ease of use and high strength.

I. Glutaraldehyde containing tooth desensitizers/disinfectants are very successful on all tooth preparations to prevent post-operative tooth sensitivity *(Microprime G from Danville, G5 from Clinicians Choice, Gluma from Kulzer; see November 2009 Clinicians Report).*

J. Resin intended for use on total etch of enamel is well proven for veneers mostly or totally on enamel.

K. Ceramic veneers placed only on enamel require only phosphoric acid etching followed by glutaraldehyde product and resin cement.

L. Ceramic veneers placed on preps with enamel but with some dentin exposed should have selective enamel etch, wash, dry, glutaraldehyde, self-etch bond on all prep and seat with resin cement. This proven technique reduces or eliminates post-op tooth sensitivity.

Tooth preparations with at least 4mm measured from the apical prep margin to the occlusal table with no more than 20° lack of parallelism can be luted with RMGI rather than bonding with resin, reducing removal challenges and increasing cariostatic activity.

M. Conventional glass ionomer cements require many hours for optimum strength. Advise patients to avoid heavy chewing and sticky foods for a day.

N. Inlays and onlays are best desensitized by using selective etch on enamel only followed by glutaraldehyde product before using self-adhesive resin cement *(see I above).*

O. Polycarboxylate cement is non-irritating and is still acceptable when long-term retention is not required.

P. Zinc phosphate is not gone. It is still used by some dentists and has a long history of success. However, other categories have advantages of strength, lack of sensitivity, adequate color, low or no solubility, and cariostatic activity.

Q. Cements are expensive, ranging from about $15 to over $50/cc. Use care to avoid over use. *(See October 2011 Clinicians Report.)*

R. Removal of cement debris may be verified with post-operative radiograph if necessary.

S. "Acid etch retained Maryland bridges." Adequate grooves and mechanical retention are required for success. Panavia products by Kuraray have proven success with noble and base metal Maryland bridges.

T. Emerging tooth-colored indirect restoration types will require clinical research to identify best types of cements.

U. C&B-MetaBond by Parkell, a long-used resin product, is recognized by clinicians as a highly retentive cement for difficult low-retention situations.

Short teeth without 4mm of prep length from the prep apical margin to the occlusal table are best bonded with resin cement.

CR Conclusions:

Cement use for indirect restorations is based on many factors. One type of cement does not fit all situations. The most overall adequate cement type today for crowns and FPDs is resin-modified glass ionomer. This *Clinicians Report* provides clinical suggestions for the most commonly occurring clinical situations.