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IN THIS ISSUE

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THE BOTTOM LINE

David C. Sarrett, DMD, MS: *Editor*

Glass Ionomer Cements

Between the two self-curing pure glass ionomers evaluated, GlassLute failed to meet minimum standards for strength and acid erosion. GC Fuji Cem, GC Fuji PLUS, and RelyX Luting Plus (all resin-modified glass ionomers) were highly rated products in the survey among clinicians. GC Fuji Cem had the most favorable film thickness of all cements tested when loaded immediately; however it was completely set when tested at the manufacturer's stated working time. **GC Fuji Plus (a RMGI) and PermaCem Dual Smartmix, a compomer more comparable to a resin cement, had the highest laboratory scores. GC Fuji Plus, a resin-modified glass ionomer, appears to be a good overall choice for a luting cement with glass ionomer advantages. It had among the highest laboratory scores and ratings among clinicians.**

Glass Ionomer Restorative Materials

GC Fuji II LC, a resin-modified glass ionomer, has a good balance between laboratory measured properties and clinical evaluations by dentists and is a good choice overall in the spectrum of fluoride-releasing ionomer materials. The self-curing, true glass ionomer products GC Fuji IX GP Fast and Ketac Fil Plus Aplicap were comparable based on laboratory testing and dentist evaluation. DYRACTextra had the highest laboratory values and the overall highest ratings by dentists. However this light-cured-only product is more comparable to a resin composite and may not provide the same potential clinical advantages as other glass ionomer products.

Pit & Fissure Sealants

Etched-enamel bonded-resin sealants remain the most effective strategy for prevention of pit and fissure caries. Glass ionomer sealants should be considered when moisture control is a concern. Resin-based UltraSeal XT and Clinpro were the most highly rated products by dentists. HelioSeal and Aegis has the lowest shrinkage stress and slowest rate of stress development during curing which may contribute to better marginal seal.

GLASS IONOMER-CONTAINING CEMENTS

Lab Notes

In the ADA laboratory, we tested acid erosion, radiopacity, film thickness, compressive strength, flexural strength, flexural modulus and setting times.

To show how the products performed in relationship to one another, we are presenting our laboratory results on the following scales. The mean value for each product is shown below the product name with the standard deviation in parentheses. Products listed in the same box had similar performance according to statistical analysis of the results (One-Way ANOVA and One-Way ANOVA on Ranks, $p<0.05$).

For a complete description of our test methods, visit "www.ada.org/goto/ppr".

GC Fuji Cem
GC America
800-323-7063
www.gcamerica.com

GC Fuji PLUS – Capsule
GC America
800-323-7063
www.gcamerica.com

GlassLute
Pulpdent
800-343-4342
www.pulpdent.com

Infinity
Den-Mat
800-445-0345
www.denmat.com

Ketac Cem Aplicap
3M ESPE
800-634-2249
www.3mespe.com

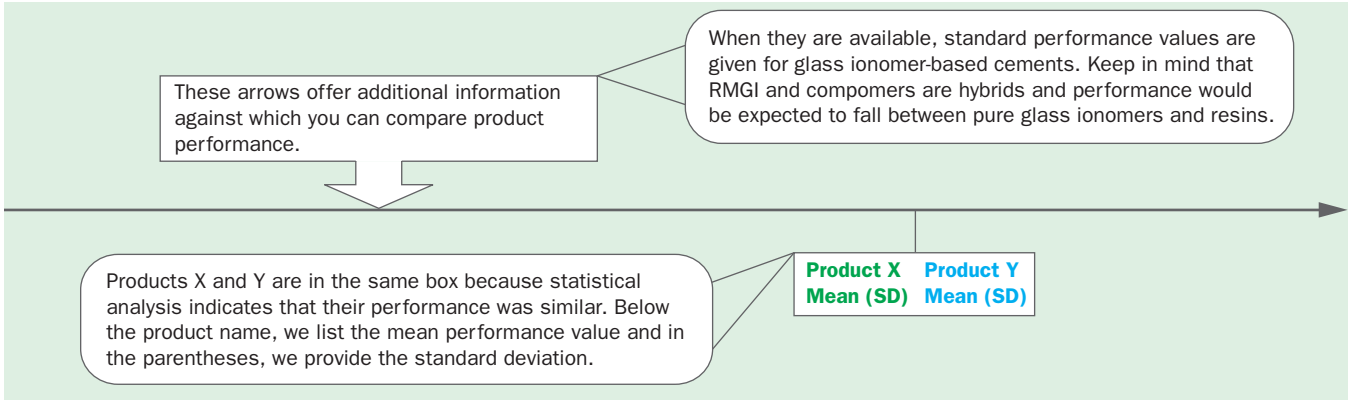
PermaCem Dual Smartmix
Zenith Dental/DMG
800-662-6383
www.zenithdental.com

Principle
DENTSPLY Caulk
800-LD-CAULK
(532-2855)
www.caulk.com

RelyX Luting Plus
3M ESPE
800-634-2249
www.3mespe.com

How to Read the Graphs

Glass Ionomer **Resin-Modified Glass Ionomer** **Polyacid-Modified Resin (Compomer)**



Acid Erosion*

(Lower values are more desirable.)

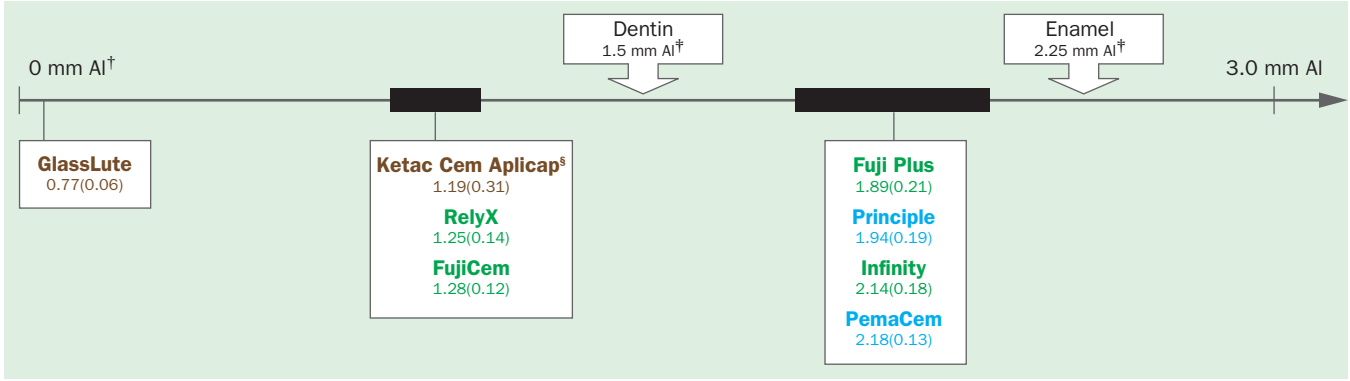
Characteristic Tested: Tests how soluble the cements are in lactic acid. The lower the number, the higher is the resistance to acid erosion. The rankings of solubility of glass ionomer cements in lactic acid, when compared to each other, have been shown to correlate well with clinical evaluations. That is, when comparing a group of traditional glass ionomer cements, research shows that solubility in lactic acid is predictive of how that group will perform in a clinical setting.[1]

* After 24 hours in lactic acid solution.
† 1 micron = 10^{-3}mm
‡ These products had ≤ 5 microns of erosion.

Radiopacity for Tested Glass Ionomer Cements.*

(Values that are higher are more desirable.)

Characteristic Tested: Indicates how identifiable the cement will be on a radiograph, which is especially important when attempting to detect any interproximally extruded cement.

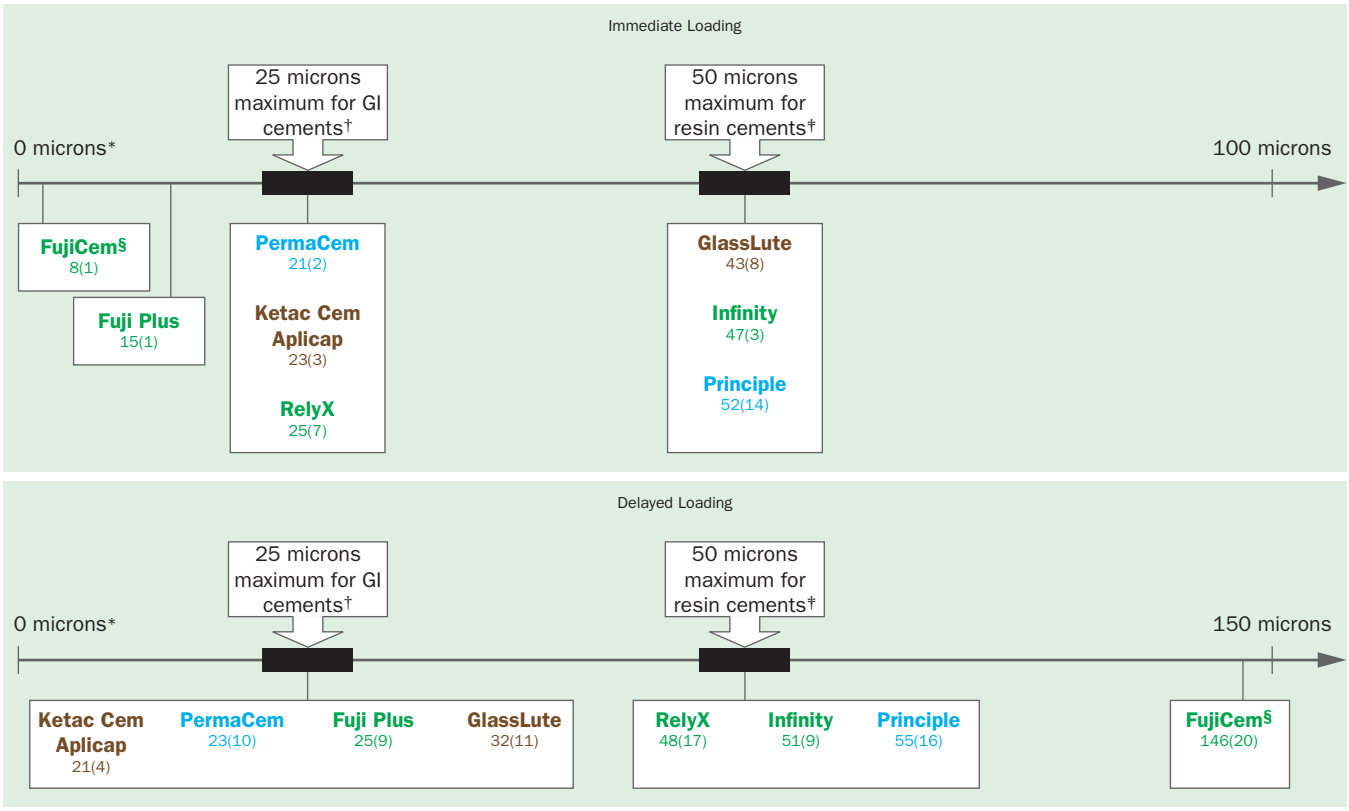


* We measured radiopacity for 1-mm thick specimens at seven days after setting.
† mm Al stands for millimeters of aluminum, a standard reference for comparing the radiopacity of different materials.
‡ Radiopacity of dentin and enamel according to Atta N, et al.[2]
§ The manufacturers of Ketac Cem Aplicap do not claim radiopacity for that product.

Film Thickness

(Lower values are more desirable.)

Characteristic Tested: Represents the thickness of the cement layer formed under pressure. We tested under two conditions: applying load immediately after mixing ("Immediate Loading") and 10 seconds before the end of the manufacturers' stated working times ("Delayed Loading").



* 1 micron=10^{-3} mm
† Maximum film thickness for water-based (glass ionomer) cements recommended by ANSI/ADA.[3]
‡ Maximum film thickness for resin-based cements recommended by ISO.[4]
§ Fuji Cem completely set and did not flow on load application.

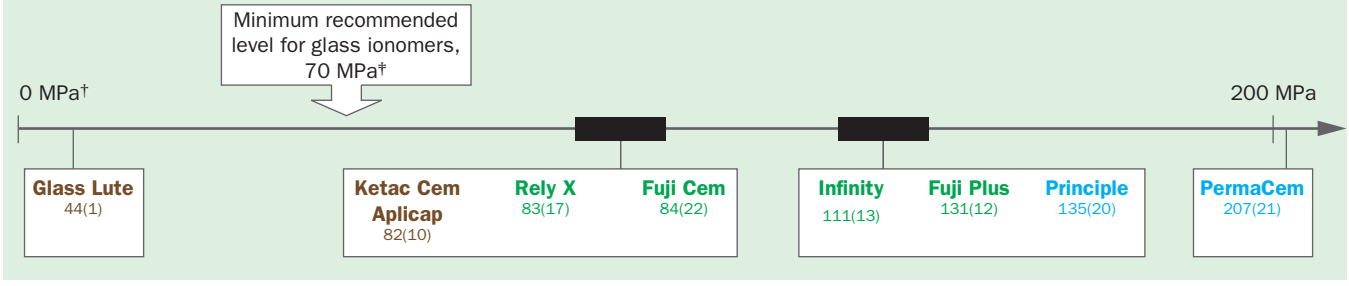
Film Thickness: GI vs. Resin Cements

The maximum value for film thickness differs when considering a GI cement compared to a resin cement. Due to the inherently higher strength, lower solubility and greater adhesive bonding of resin materials compared to glass ionomers, resin luting cements can occupy a larger space between the tooth and restoration and still function effectively as a luting cement. As the space increases in dimensions (in cases where a crown does not precisely fit a preparation), the demands on the luting cement also increase for features such as solubility and strength. Also, depending on the filler particles added to the resin, it may be more difficult to achieve a very small film thickness. Remember though that the choice between a resin and a glass ionomer initially will depend on other patient factors such as moisture control (See Academic Corner, p. 15). Another point to keep in mind is that these cements, when used at oral temperature, set faster (see Setting Time, p. 4). Thus, potentially higher film thickness could occur closer to end of the stated working times. As a general rule, probably all but FujiCem could be considered satisfactory results under the conditions tested.

Compressive Strength for Tested Glass Ionomer Cements.*

(Higher strengths are more desirable; although no clinically relevant minimum has been established.)

Characteristic Tested: Measures the cement's ability to withstand compression, (e.g., vertical chewing forces.)[3]

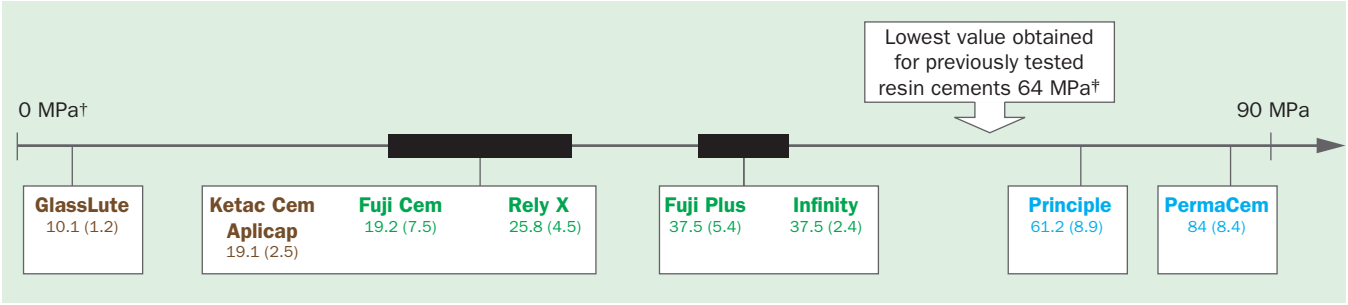


* Result is the force/unit area (strength) required to break a standard specimen in compression.
† MPa stands for megapascal, a unit of strength (force/unit area).
‡ Minimum desired compressive strength for water-based (glass ionomer) cements recommended by American National Standards Institute/ADA.[3] There is no minimum recommended level for resin-based cements.

Flexural Strength for Tested Glass Ionomer Cements.*

(Higher strengths are more desirable; although no clinically relevant minimum has been established.)

Characteristic Tested: This test determines the strength in resistance to flexural (bending) loads. For example, when a cement is used as a luting agent under a crown, the system (including the crown, the cement and the underlying tooth) can be subjected to bending from lateral forces. In such cases, consideration of flexural strengths may become important. Remember that other properties such as film thickness affect the relative importance of this property. *See discussion under film thickness.*

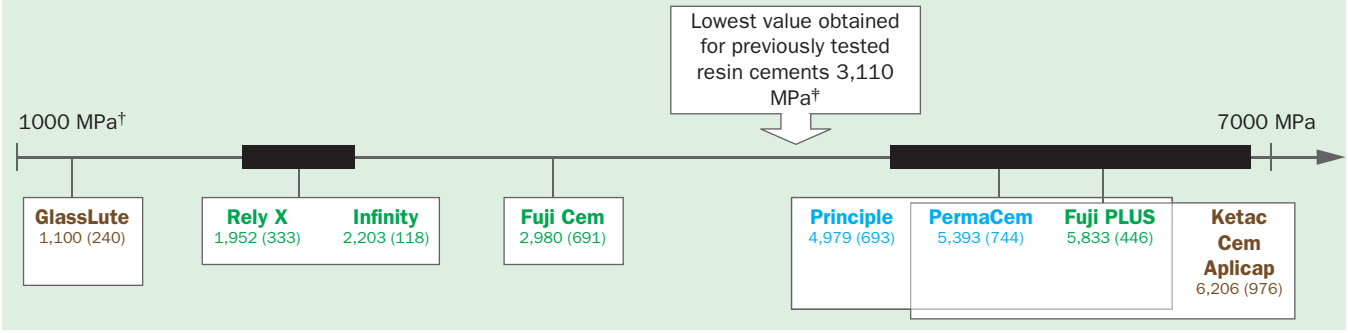


* We used a three-point bend test to measure flexural properties of standard beam specimens. The result is the maximum force/unit area required for failure of a specimen.
† MPa stands for megapascal, a unit of strength (Force/unit area).
‡ Flexural strength of resin-based cements tested for PPR 1(2) ranged from a mean (SD) of 64 (6) to 124 (14) MPa.[5] The International Organization for Standardization recommends a minimum flexural strength for resin-based cements of 50 MPa.[4] There is no minimum standard value established for glass ionomer cements.

Flexural Modulus (Stiffness) for Tested Glass Ionomer Cements.*

(A higher modulus will provide better resistance to deformation under occlusal forces)

Characteristic Tested: This test determines stiffness of the cement (higher numbers indicate increased stiffness in bending). Ideal stiffness for a cement may depend on the location on the tooth as well as occlusal loading. Considering the flexural modulus of dentin (at approximately 20,000 MPa)[6] and these representative values for cements, probably the higher the resistance to flexural bending the better.



* We used a three-point bend test to measure flexural properties of standard beam specimens. Result is a calculated stress/strain value from the slope of the loading curve from the flexure test.
† MPa stands for megapascal, a unit of modulus.
‡ Flexural modulus of resin-based cements tested for PPR 1(2) ranged from a mean (SD) of 3,110 (700) to 8,480 (470) MPa.[5] There are no recommended minimum levels for glass ionomer or resin-based cements.

References

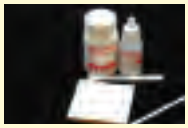
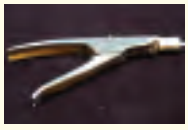
1. Craig RG, Powers JM. Restorative dental materials. 11th edition St. Louis: Mosby, 2002. p 616.
2. Attar N, Tam LE, McComb D. Flow, strength, stiffness and radiopacity of flowable resin composites. J Can Dent Assoc 2003;69(8):516-21.
3. American National Standard/American Dental Association Specification No. 96–2000, Dental Water-Based Cements. Chicago: American Dental Association.
4. International Organization for Standardization. ISO No. 4049–2000, Dentistry–Polymer-based filling, Restorative and Luting Materials. Geneva:ISO.
5. American Dental Association. Resin-based Cements. ADA Professional Product Review 2006;1(2):7.
6. Plotino G, Grande NM, Bedini R, Pamiejer CH, Somma F. Flexural properties of endodontic posts and human root dentin. Dent Mater 2007;23(9):1129-35.

Setting Time: **Tested vs. Manufacturer Stated.**

Product Manufacturer	**Tested Setting Time*** minutes:seconds (SD)	**Manufacturer Stated Setting Time** minutes:seconds
GC Fuji Cem GC America	2:14 (6)	5:15†
GC Fuji PLUS - Capsule GC America	2:10 (0)	5:00†
GlassLute Pulpdent	6:12 (12)	6:20‡
Infinity Den-Mat	2:10 (0)	2:00‡
Ketac Cem Aplicap 3M ESPE	4:12 (13)	7:00‡
PermaCem Dual Smartmix Zenith Dental/DMG	3:06 (6)	5:00‡
Principle DENTSPLY Caulk	3:50 (14)	3:00‡
RelyX Luting Plus 3M ESPE	2:50 (6)	5:00‡

* Measured at 37°C, 50 percent humidity.
† Measured at 23°C, humidity not known.
‡ Measured at 37°C, humidity not known.

Table 1. **Glass Ionomer-Containing Cement Features According to the Manufacturer.**

	Product Manufacturer		Setting Reaction	Shelf Life* (months)	Dispensing System	Required Accessories†	Cost‡
Glass Ionomers	**GlassLute** Pulpdent		Acid/base reaction	36	Powder/liquid —requires mixing	None	$52 (30 g powder, 15 ml liquid, mixing pad, scoop
	Ketac Cem Aplicap 3M ESPE		Acid/base reaction	36	Capsule	Activator Applicator Rotomix	$293 fifty capsules, activator, applier
Resin-Modified Glass Ionomers	**GC Fuji Cem** GC America		Acid/base reaction Autopoly-merization	24	Paste/paste —requires mixing	Mixing pad Spatula	$191 two 7.2-ml cartridges, dispenser
	GC Fuji PLUS – Capsule GC America		Acid/base reaction Autopoly-merization	24	Capsule	Applicator Triturator	$208 fifty capsules, applier
	Infinity Den-Mat		Acid/base reaction Autopoly-merization Photopoly-merization	24	Dual syringe with self-mixing tip	None	$299 three 10-g syringes, 40 auto-mixing tips, four intraoral tips
	RelyX Luting Plus 3M ESPE		Acid/base reaction Autopoly-merization	24	Paste/paste —requires mixing	Mixing pad Spatula	$93 one clicker dispenser
Compomers	**PermaCem Dual Smartmix** Zenith Dental/DMG		Acid/base reaction Autopoly-merization	24	Dual syringe with self-mixing tip	None	$168 two 10-g syringes, 10 tips
	Principle DENTSPLY Caulk		Acid/base reaction Autopoly-merization Photopoly-merization	24	Powder/liquid —requires mixing	Mixing pad Spatula	$114 12 g powder, 6 g liquid, scoop, mixing pad

* From date of manufacture.
† Must be purchased separately from quoted kit.
‡ Catalog prices. Your purchase price may vary.

Practitioner Input

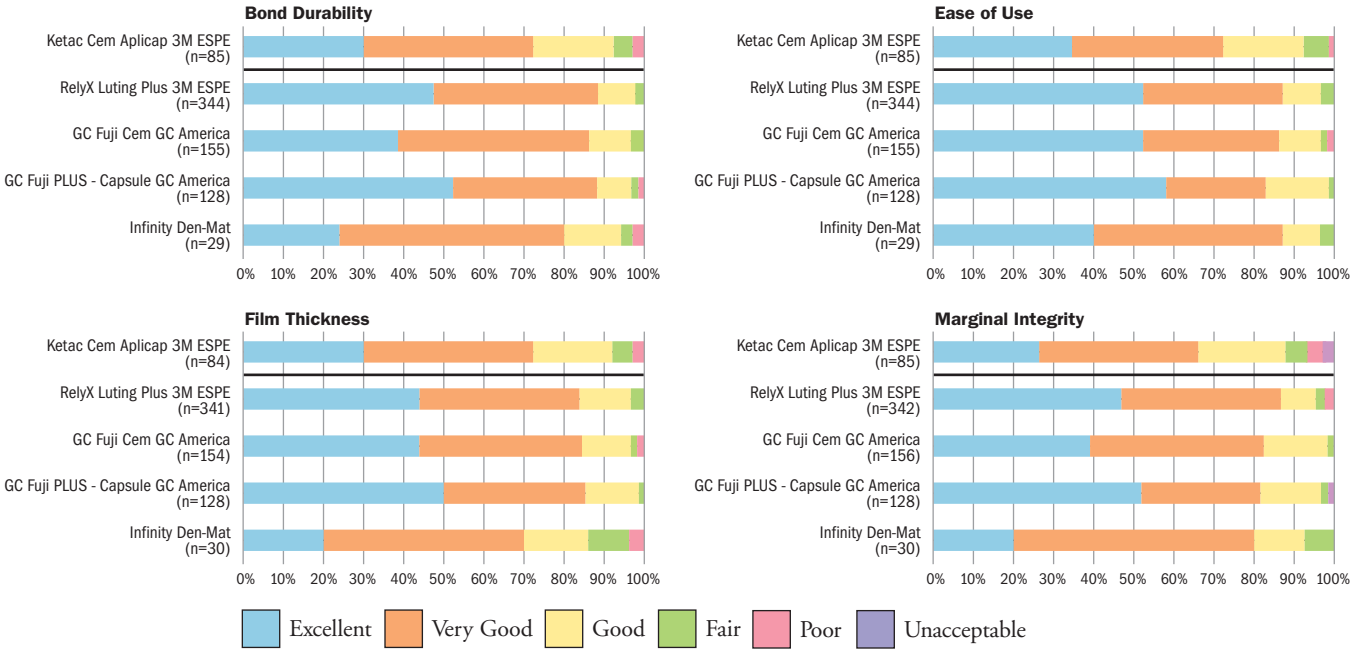
Through a Web-based survey, we collected 758 surveys from dentists about their experiences with the glass-ionomer containing cements featured in this report. Participants were drawn from the ADA Clinical Evaluators (ACE) Panel and a random sample of other ADA members.

GlassLute, PermaCem Dual Smartmix, and Principle are not shown in these charts due to a small number of respondents for those products.

Ketac Cem Aplicap is set apart from the others because it is a glass ionomer cement; the others are resin-modified glass ionomer cements.

Table 2. **Best, Worst Features of Reviewed Glass Ionomer Cements, According to Surveyed Dentists.**

Product Manufacturer	Best Feature (n)	Worst Feature (n)
GC Fuji Cem GC America	Easy to mix, dispense (35)	None (54)
GC Fuji PLUS –Capsule GC America	Easy to mix, dispense (24)	None (40)
Infinity Den-Mat	Easy to mix, dispense (9)	Price (13)
Ketac Cem Aplicap 3M ESPE	Easy to mix, dispense (15)	Price (18)
RelyX Luting Plus 3M ESPE	Low technique sensitivity (55)	None (117)



GLASS IONOMER-CONTAINING RESTORATIVES

Lab Notes

In the ADA laboratory, we tested acid erosion, depth of cure, radiopacity, compressive strength, flexural strength, flexural modulus, setting times, transmittance and shade/color stability.

To show how the products performed in relationship to one another, we are presenting our laboratory results on the following scales. Products listed in the same box had similar performance according to statistical analysis of the results (One-Way ANOVA and ANOVA on Ranks, $p<0.05$). Results are given as mean values with the standard deviations in parentheses.

For a complete description of our test methods, visit "www.ada.org/goto/ppr".

For a guide to reading the following figures, see p. 2.

Setting Time*

NOTE: This test applies only to products whose setting reaction is initiated by chemical agents without light activation (i.e., self-cure and dual-cure products only).

Manufacturers often list setting times among the product information, but they rarely provide the test conditions (e.g., temperature, humidity) under which those times were determined. In collecting information from the manufacturers, we asked about test conditions. In our own testing, we measured setting times at 37°C and 90 percent relative humidity to clinically simulate conditions in the mouth.

The values listed below are not presented as better or worse. That judgment depends on the individual practice needs and evaluation of the practitioner. In addition to general clinical concerns, also consider the ease of use of the mixing and delivery system to determine acceptable working and setting times.

Setting Time: **Tested vs. Manufacturer Stated.**

Product Manufacturer	**Tested Setting Time*** minutes:seconds	**Manufacturer Stated Setting Time** minutes:seconds†
GC Fuji IX GP Fast‡ GC America	1:36	3:00
Geristore Den-Mat	4:02	4:00
Ketac Fil Plus Aplicap 3M ESPE	2:24	7:00
riva self cure SDI, North America, Inc.	2:26	4:30
Vitremer 3M ESPE	4:50	4:00

* Measured at 37°C, 90 percent humidity.
† Measured at 37°C and humidity not known.
‡ Also sold as regular set.

Compoglass Flow
Ivoclar Vivadent
800-533-6825
www.ivoclarvivadent.us

DYRACTextra
DENTSPLY Caulk
800-LD-Caulk
www.caulk.com

GC Fuji II LC
GC America
800-323-7063
www.gcamerica.com

GC Fuji IX GP Fast
GC America
800-323-7063
www.gcamerica.com

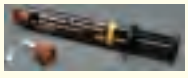
Geristore
Den-Mat
800-445-0345
www.denmat.com

Ketac Fil Plus Aplicap
3M ESPE
800-634-2249
www.3mespe.com

riva self cure
SDI North America, Inc.
800-228-5166
www.sdi.com.au

Vitremer
3M ESPE
800-634-2249
www.3mespe.com

Table 1. **Glass Ionomer-Containing Restorative Features According to the Manufacturer.**

	Product Manufacturer	Indications for Use*	Setting Reaction	Shelf Life (months)	Delivery System	Accessories Required‡	Cost§ (contents)
Glass Ionomers	**GC Fuji IX GP Fast** GC America 	Small Class II	Acid/base reaction	24	Capsule	Triturator	$258 (50 capsules [assorted shades], capsule applicator, 5.7 ml cavity conditioner, 5.2 ml Fuji Coat LC)
	Ketac Fil Plus Aplicap 3M ESPE 	Class III, Fissure sealing	Acid/base reaction	24	Capsule	Rotomix	$326 (50 capsules [assorted shades], applicator, activator)
Resin-Modified Glass Ionomers	**riva self cure** SDI, North America, Inc. 	Small Class II, Root surface	Acid/base reaction	27	Capsule	Triturator	$139 (50 capsules [assorted shades], capsule applicator, 5 ml Riva Coat, 10 ml conditioner)
	GC Fuji II LC GC America 	Class III	Photopolymerization Acid/base reaction	24	Capsule	Applicator Curing Light Triturator	$185 (50 capsules)
	Geristore Den-Mat 	Luting indirect restorations	Photopolymerization Autopolymerization Acid/base reaction	18	Syringe with dual, self-mixing tip	Curing Light	$135 (10 g shade A2 syringe, 15 mixing tips)
	Vitremer 3M ESPE 	Root surface	Photopolymerization Autopolymerization Acid/base reaction	36	Powder/ Liquid	Curing Light	$500 (5 g powder [assorted shades], two 8 ml liquids, 6.5 ml primer, 6.5 ml finishing gloss, delivery tips with pistons, spoon, mixing pad, shade guide, well, brush tips and handle)
Compomers	**Compoglass Flow** Ivolclar Vivadent 	Root Surface, Class III	Photopolymerization	24	Paste	Compule Gun Curing Light	$63 (twenty 0.25-g compules)
	DYRACTextra DENTSPLY Caulk 	All class of restorations	Photopolymerization	24	Paste	Compule Gun Curing Light	$96 (twenty 0.25-g compules)

* Apart from small Class I and V, base/liner, intermediate, deciduous, core with some tooth support. NOTE: Instruction sheet for DYRACTextra indicates that this product can be used for "all classes of restorations." Additional uses as core material or base are not mentioned.

‡ Must be purchased separately from quoted kit.

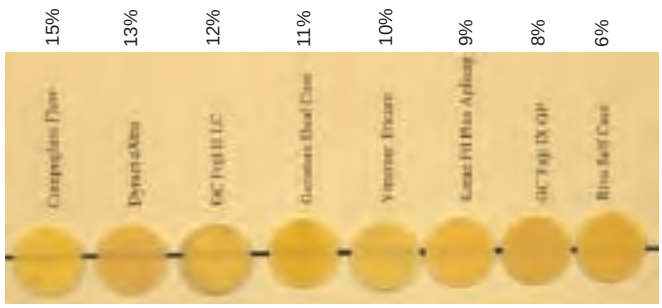
§ Catalog prices. Actual retail price may vary depending on vendor and quantity ordered.

Transmittance*

(Higher percentage of light transmittance indicates relatively greater translucence.)

Characteristic Tested: Translucency can enhance the esthetics of anterior restorations. Less translucent (more opaque) materials may be preferred when placing a restoration over any discoloration, such as, non-vital or stained teeth.

* We measured the percentage of light transmitted through 1-mm thick specimens using a standard light source.



Color Stability

Characteristic Tested: This test confirms the restorative's ability to maintain the same shade after exposure to simulated aging.

Results: All of the products passed this test. There was no, or only slight, difference in shade between the test and control specimens or the test specimens and the VITA A3 shade tab.

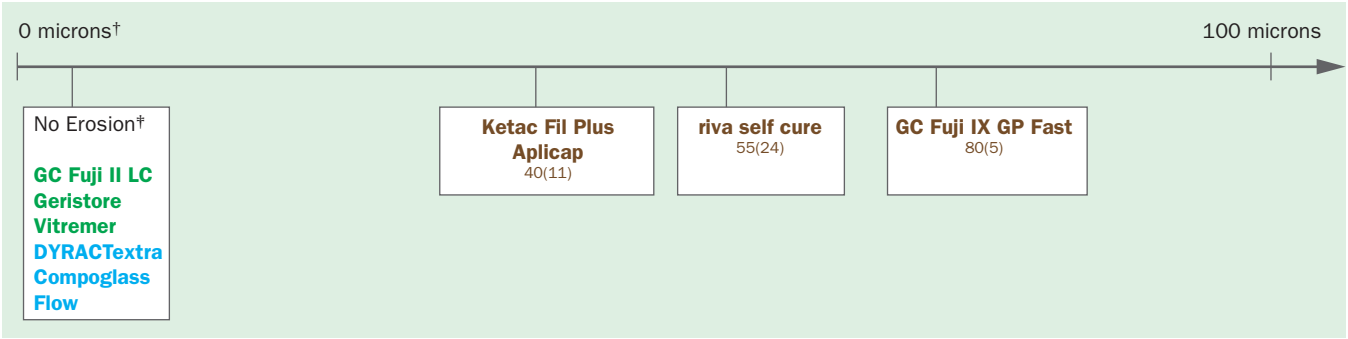
How to Read the Graphs

Glass Ionomer | Resin-Modified Glass Ionomer | Polyacid-Modified Resin (Compomer)

Acid Erosion*

(Lower values are more desirable.)

Characteristic Tested: Tests how soluble the restoratives are in lactic acid. Lower values indicate greater resistance to acid erosion.

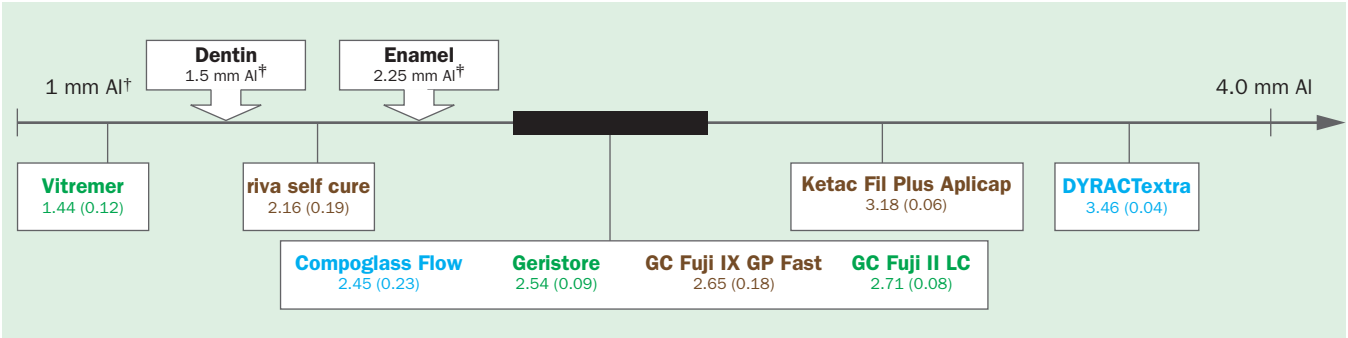


* After 24 hours in a lactic acid solution (pH 2.74)
† 1 micron = 10^{-3}mm
‡ These products had ≤ 5 microns of erosion.

Radiopacity *

(Values that are greater than enamel are more desirable.)

Characteristic Tested: Indicates how identifiable the restoration will be on a radiograph.

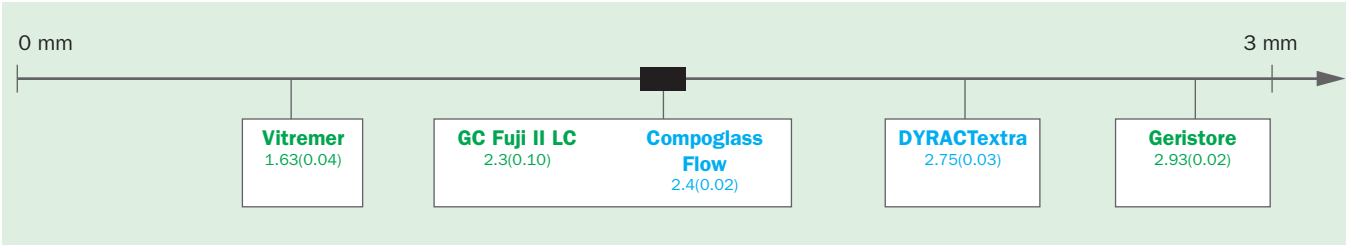


* We measured radiopacity for 1-mm thick specimens at seven days after setting.
† mm Al stands for millimeters of aluminum, a standard measurement used for comparing the radiopacity of different materials.
‡ Radiopacity of dentin and enamel according to Attar N, et al.[1]

Depth of Cure*

(Higher values are more desirable.)

Characteristic Tested: This test indicates the total depth to which the material (in this case, VITA shade A3) will cure when activated with a high-intensity tungsten halogen light for 20 seconds. Note that depth of cure values may vary depending on the curing light used and the shade of the material being cured.

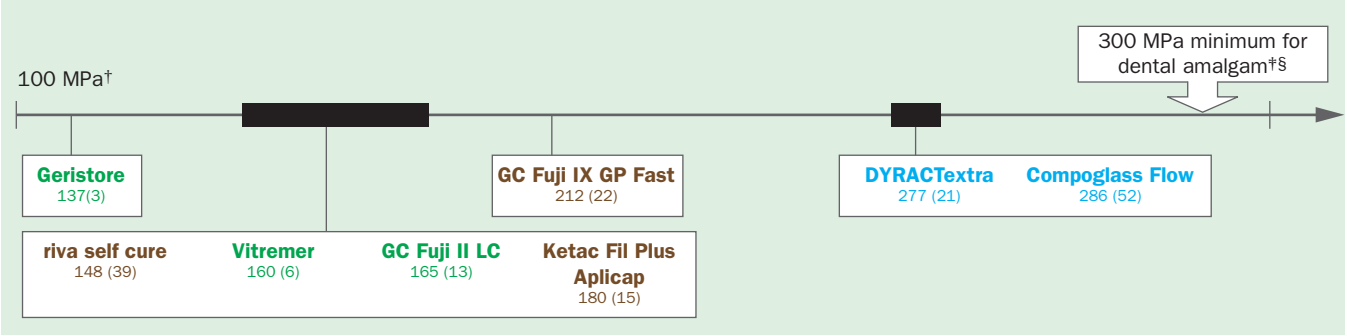


* Applies only to products that can be activated with a curing light (i.e., dual-cure and light-cure products only).

Compressive Strength*

(Higher values are more desirable; although no clinically relevant minimum has been established.)

Characteristic Tested: Measures the restorative's ability to withstand compression (e.g., vertical chewing forces). Higher numbers indicate greater strength.

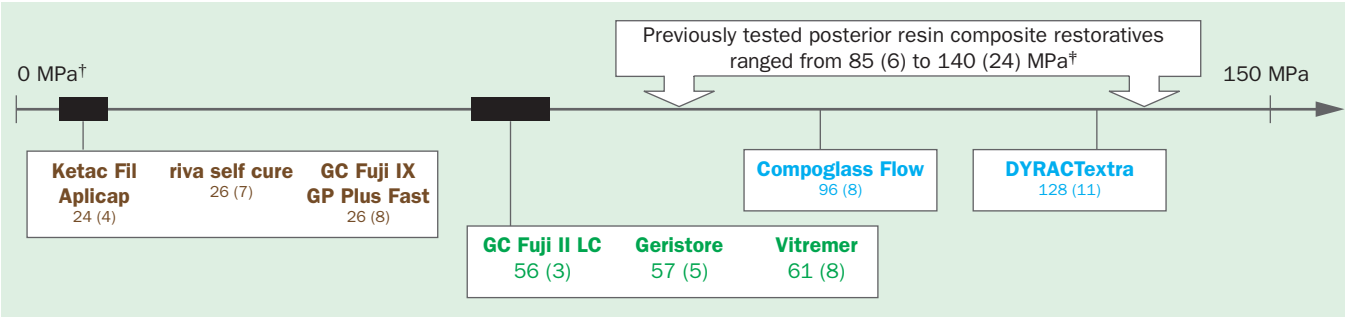


* Result is the force/unit area (strength) required to break a standard specimen in compression.
† MPa stands for megapascal, a unit of strength (force/unit area). 1 MPa = 145 psi.
‡ Based on a cross-head speed of 0.5 mm/min. According to ANSI/ADA Specification No. 1.[2]
§ Typical compressive strength for different dental amalgams range from 300 to 445 MPa.[3]

Flexural Strength*

(Higher strengths are more desirable; although no clinically relevant minimum has been established.)

Characteristic Tested: This test determines the strength in resistance to flexural (bending) loads.

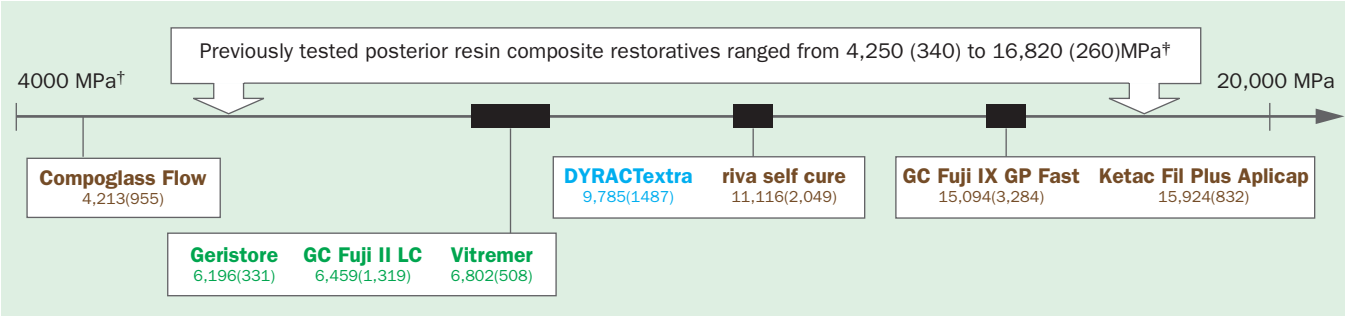


* We used a three-point bend test to measure flexural properties of standard beam specimens. The result is the maximum force/unit area at failure of a specimen.
† MPa stands for megapascal, a unit of strength (force/unit area). 1 MPa = 145 psi.
‡ Flexural strength of posterior resin composite restoratives tested for PPR 1(1).[4]

Flexural Modulus (Stiffness)*

(A higher modulus will provide better resistance to deformation under occlusal forces)

Characteristic Tested: This test determines stiffness of the restorative (higher numbers indicate increased stiffness in bending). A clinically optimum range for flexural modulus has not been determined. Ideal stiffness for a restorative depends on the location of the tooth as well as occlusal loading.



* We used a three-point bend test to measure flexural properties of standard beam specimens. Result is a calculated stress/strain value from the slope of the loading curve from the flexure test.
† MPa stands for megapascal, a unit of modulus. 1 MPa = 145 psi.
‡ Flexural modulus of posterior resin composite restoratives tested for PPR 1(1).[4]

Academic Corner

Should dual-cured products be light activated whenever possible?

We found that dual-cure products continue to cure after exposure to the curing light. To test this, we prepared five specimens and stored them in the dark for 24 hours. We then prepared a second set of five specimens, which we light cured and then stored in the dark for 24 hours. (Our tests did not assess the degree of conversion, which determines the final material properties.)

Results on flexural and compressive strengths indicate that light-cured samples (samples that cured by light activation in addition to the chemical initiated polymerization reaction) provided higher strengths than samples that were allowed to harden in the self-cure mode only.

Depth of Cure

Product Manufacturer	**Immediately after light curing mm (SD)**	**30 minutes after light curing (dual cured) mm**	**30 minutes, self curing only mm**
Geristore Den-Mat	2.93 (0.02)	>3	>3
Vitremer 3M ESPE	1.63 (0.04)	>3	>3

Compressive Strength

Product Manufacturer	**24 hours after light curing (dual cured) MPa (SD)**	**24 hours, self curing only MPa (SD)**
Geristore Den-Mat	137 (3)*	125 (23)*
Vitremer 3M ESPE	160 (6)	124 (10)

Flexural Strength

Product Manufacturer	**24 hours after light curing (dual cured) MPa (SD)**	**24 hours, self curing only MPa (SD)**
Geristore Den-Mat	61 (8)	36 (6)
Vitremer 3M ESPE	57 (5)	47 (5)

* Similar performance according to statistical analysis t-test ($p<0.05$)

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2. American National Standard/American Dental Association Specification No. 1 2003, Alloy for dental amalgam. Chicago: American Dental Association.
3. University of Michigan. Ultimate compressive strength, C. Available at: http://www.lib.umich.edu/dentlib/Dental_tables/Ultcompstr.html. Accessed October 9, 2007.
4. American Dental Association. Posterior composite resins. ADA Professional Product Review 2006;1(1):5.

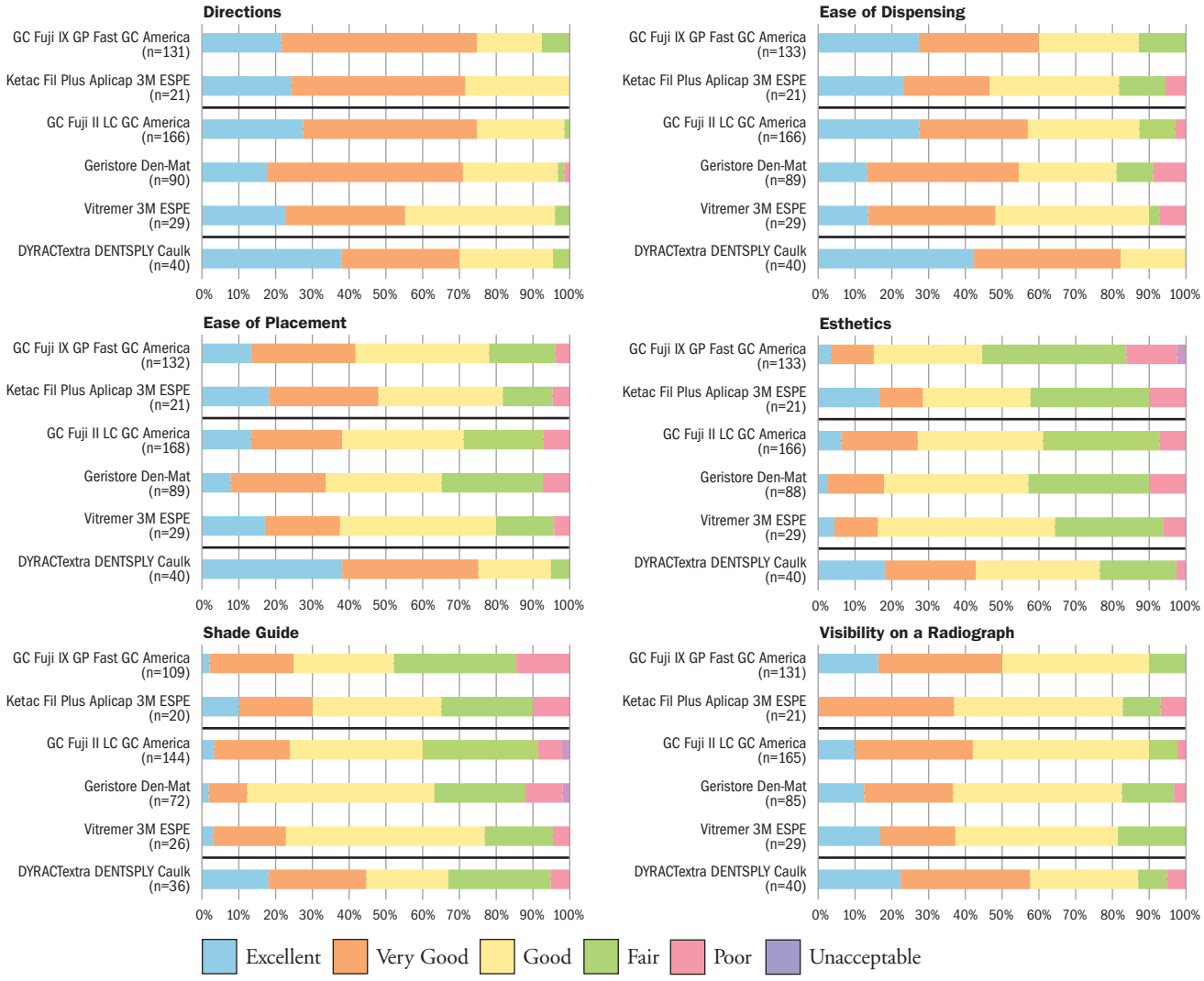
Practitioner Input

Through a Web-based survey, we collected input from 498 dentists about their experiences with the glass-ionomer containing restoratives featured in this report. Respondents rated up to two restorative brands. Participants were drawn from the ADA Clinical Evaluators (ACE) Panel and a random sample of other ADA members.

NOTE: Compoglass Flow and riva self cure had too few responses to reliably report clinical impressions and are not included in this section of the report.

Table 2. **Best, Worst Features for Reviewed Glass Ionomer Restoratives, According to Surveyed Dentists.**

	Product Manufacturer	**Best Feature** (n)	**Worst Feature** (n)
Glass Ionomers	GC Fuji IX GP Fast	Low technique sensitivity (34)	Inadequate shade match (51)
	Ketac Fil Plus Aplicap	Low technique sensitivity (3) and published clinical studies (3)	Difficult to mix/ dispense (6)
Resin-Modified Glass Ionomers	GC Fuji II LC	Low technique sensitivity (36)	Inadequate shade match (40)
	Geristore	Good marginal seal (15)	Inadequate working time (18)
	Vitremer	Low technique sensitivity (4) and published clinical studies (4)	Inadequate shade match (7) and cost (7)
Compomers	DYRACTextra	Low technique sensitivity (10)	Inadequate shade match (10)



PIT & FISSURE SEALANTS

Lab Notes

In the ADA laboratory, we tested setting time for the glass ionomer based sealants. For the resin-based sealants, we tested depth of cure, and polymerization shrinkage stress and rate of stress development.

For a complete description of our test methods, visit "www.ada.org/goto/ppr".

Setting Time: **Tested vs. Manufacturer Stated.**

Product Manufacturer	**Tested Setting Time*** minutes:seconds	**Manufacturer Stated Setting Time** minutes:seconds
GC Fuji TRIAGE (white) GC America, Inc.	2:42 (0:16)	2:45†
riva protect, regular set SDI America, Inc.	2:12 (0:05)	4:10‡
riva protect, fast set SDI America, Inc.	2:28 (0:13)	2:00‡

* Measured at 37° C, 90 percent humidity.
† Measured at 23°C, humidity not known.
‡ Measured at 37°C, humidity not known.

Aegis Pit & Fissure Sealant
Harry J. Bosworth Company
800-323-4352
www.bosworth.com

Clinpro
3M ESPE
800-634-2249
www.3mespe.com

Delton Light Cure
DENTSPLY Professional
800-989-8826
www.dentsply.com

Embrace WetBond
Pulpdent Corp.
800-343-4342
www.pulpdent.com

GC Fuji TRIAGE
GC America, Inc.
800-323-7063
www.gcamerica.com

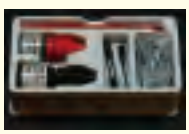
Guardian Seal
Kerr Corp.
800-537-7123
www.kerrdental.com

Helioseal
Ivoclar Vivadent
800-533-6825
www.ivoclarvivadent.us

riva protect
SDI North America, Inc.
800-228-5166
www.sdi.com.au

UltraSeal XT plus
Ultradent Products
800-552-5512
www.ultradent.com

Table 1. **Pit and Fissure Sealant Features According to Manufacturer.**

	Product Manufacturer		Therapeutic Benefit	Filler Content (% volume)	Available Shades	Color Change to Indicate Set	Shelf Life (years)	Delivery System	Price* (Contents)
Glass Ionomers	**GC Fuji TRIAGE** GC America, Inc.		Fluoride release	40%	Pink White	NA	2	Capsule with applier	$148 (50 capsules, applicator, Fuji coat, cavity conditioner)
	riva protect SDI North America, Inc.		Fluoride release, also contains ACP†	44.3%, regular set 47.6% fast set	Bleach Pink	NA	3 (capsules)	Pre-dosed capsule or hand-mix powder/liquid (regular set only)	$114 (50 capsules, applicator)
Resins	**Aegis Pit & Fissure Sealant** Harry J. Bosworth Company		No, releases ACP†	16.5% ACP†	Opaque	No	3	Syringe	$106 (three 1.2 ml sealant syringes, one 3 ml etchant syringe, 40 tips)
	Clinpro 3M ESPE		Fluoride release	3%	Opaque	From pink to opaque off white	2	Syringe	$61 (two 1.2 ml sealant syringes, one 3 ml etchant syringe, 20 tips)‡
	Delton Light Cure DENTSPLY Professional		No	None	Clear Opaque	No	2	Tube applicator	$94, clear $93, opaque (two 2.7 ml sealant bottles, one 7 ml etchant, tube applicator, mixing trays)
	Embrace WetBond Pulpdent Corp.		Fluoride release	NA§	Off White Natural	No	2	Syringe or Unit-dose pipette	$63 (four 1.2 ml syringes, 20 applicator tips)
	Guardian Seal Kerr Corp.		Fluoride release	14.4%	Not Shaded	No	2	Syringe	$82 (four 1 g syringes, 40 microbrush applicator tips)
	Helioseal Ivoclar Vivadent		NoII	None	White	No	1.5	Bottle with cannula applicator tips	$128 (8 g etchant, 20 plastic tips, 10 plastic cannulas, 50 brushes, one brush/tip holder)
	UltraSeal XT plus Ultradent Products		Fluoride release	33.8%	Clear A1 A2 Opaque White	No	2	Syringe with brush	$49 (one 1.2ml UltraSeal XT plus syringe, one 1.2ml Ultra-Etch syringe, two 1.2 ml PrimaDry syringes, twenty Blue Micro Tips, twenty Inspiral Brush Tips)

* Catalog prices. Actual retail price may vary depending on vendor and quantity ordered.
† Amorphous calcium phosphate
‡ Bottle kit also available.
§ Not available from the company.
II Helioseal does not contain fluoride; Helioseal F contains fluoride.

What is ACP?

Developed by the ADA Foundation Paffenbarger Research Center, amorphous calcium phosphate (ACP) is a novel nonfluoride therapy shown to remineralize enamel and dentin.

According to an article in the ADA News,[1] ACP works by depositing and then dissolving in oral fluids. Once it dissolves, it is transported into the carious lesion where the calcium and phosphate ions precipitate and recrystallize as apatite to repair early lesions.

In addition to remineralizing early carious lesions, ACP is useful as a desensitizer. Several products have been licensed by Paffenbarger Research Center to deliver ACP including EnamelCare toothpaste and Mentadent Replenishing White (Church & Dwight Co.), Enamel Pro Series prophy paste and fluoride varnish (Premier Dental), bleaching gels (Discus Dental) and an orthodontic cement (H.J. Bosworth Co.).

For a more detailed article on ACP, see the August 20, 2007, ADA News[1] or any of the scientific articles listed below.[2-5] For more information about the ADA Foundation Paffenbarger Research Center, visit "http://www.ada.org/ada/prod/adaf/paffenbarger/index.asp".

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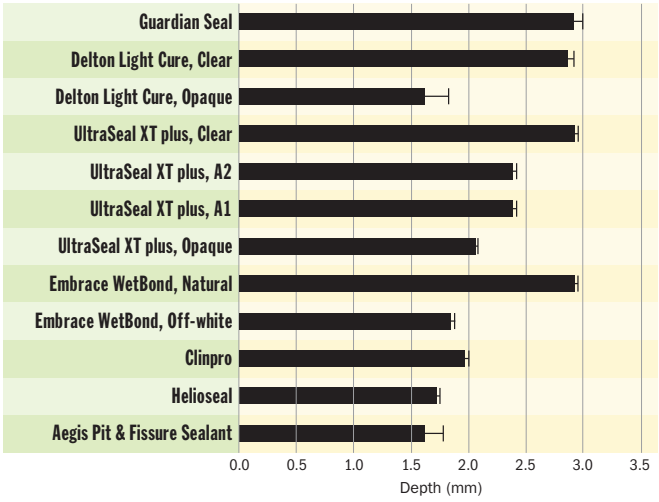
5. Skrtic D, Antonucci JM, Eanes ED, Eidelman N. Dental composites based on hybrid and surface-modified amorphous calcium phosphates. Biomaterials 2004;25:1141-50.

Resins: Depth of Cure

NOTE: Depth of cure values depend on the type of curing light being used and the shade of material being cured among others factors. We used a tungsten halogen curing light and tested multiple shades as listed in Figure 1.

Figure 1. **Depth of Cure**



Resins: Polymerization Shrinkage Stress & Rate of Stress Development

(Lower values are more desirable.)

Characteristic Tested: As the title suggests, this test indicates the amount of shrinkage during polymerization and the rate of stress development. Greater stresses at the margins during polymerization may compromise the seal as the resin shrinks away from the surrounding tooth structure, thus weakening the bond.

Figure 2. **Shrinkage Stress (MPa)**

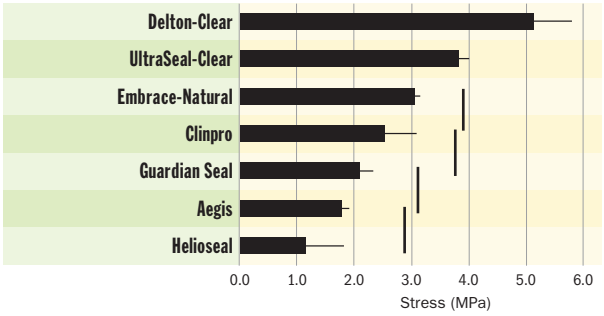
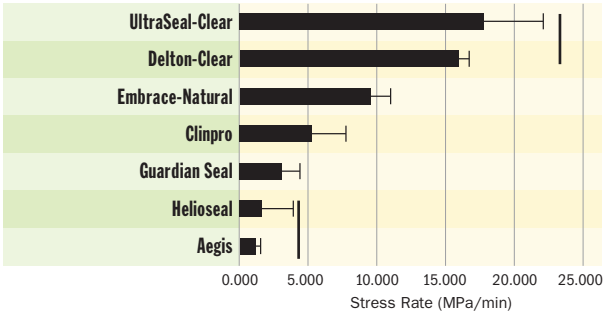


Figure 3. **Rate of Stress Development**

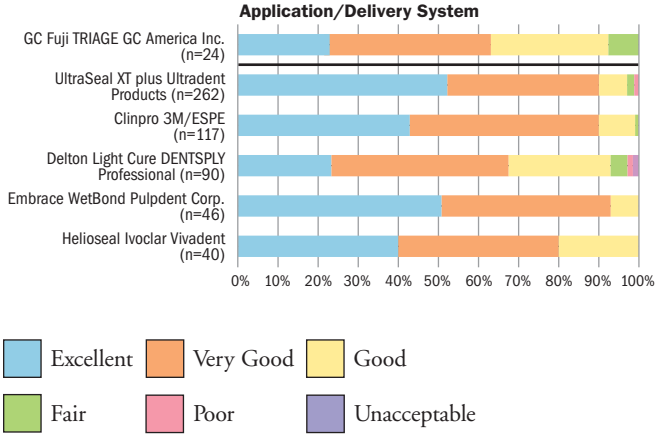


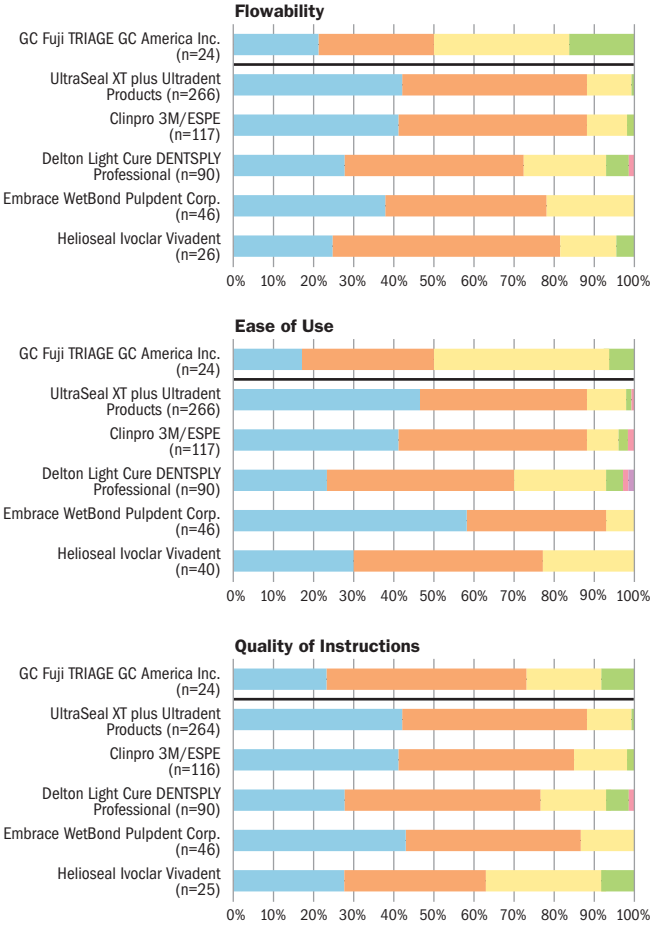
Practitioner Input

Through a Web-based survey, we collected 570 surveys from dentists about their experiences with the sealants featured in this report. Participants were drawn from the ADA Clinical Evaluators (ACE) Panel and a random sample of other ADA members.

Aegis Pit & Fissure Sealant, Guardian Seal and riva protect are not shown in these charts due to a small number of respondents for those products. These response rates were not considered sufficient to allow reliable comparison to the other products.

The bars on each chart are arranged by the number of responses we obtained for that product. Greater number of responses implies greater strength of data obtained. GC Fuji TRIAGE is set apart from the others because it is a glass ionomer sealant; the remaining products are methacrylate-based resins.





ACADEMIC CORNER

The Academic Corner, a new feature of the PPR, offers interested readers detailed information on the science behind the topics. This issue's debut column explores fluoride-containing dental materials.

Understanding Fluoride-Containing Materials: Glass-ionomer (GI), Resin Modified GI (RMGI), and Poly-Acid Modified Resin (Compomers)

This issue evaluates and compares products within three categories – each of which has products that contain glass ionomer as a component. These products all cite fluoride release as a principal product claim. Resins also can be an ingredient or even the major structural component of products within these categories. In selecting the right product for the right application, it is helpful to review the major advantages and relative importance of each material for the particular clinical application.

This introduction is presented to help in the selection of different products – all of which are described as taking advantage of glass ionomer properties to some extent, and generally with a manufacturer claim of fluoride release. The articles in this issue are grouped according to product use (i.e., pit and fissure sealants, cements and restoratives). Since the actual products tested are composed of slightly different materials with different properties, it would not be fair to judge them compared strictly to one another. Rather, the question of which material is most suitable for each clinical application must first be addressed. As the material becomes composed of more resin as its matrix, the advantages of the glass ionomer will tend to decrease and the composite-like properties—esthetics, strength, etc.—will improve. (See Figure) The question for the practitioner is: How much of each property do you need for a given clinical application? Once this is determined, a product can be chosen within the variations available for that application based on the product features, cost, etc.

Resin-Modified Glass Ionomers (RMGI) and Poly-Acid Modified Resins (PAMR; Compomers): Are they really different, and what difference does it make?

These two product classes can be distinguished, in theory, by whether the material is based on the polyacrylic acid chain (GI) modified with addition of a resin polymer (RMGI); or whether it is based on the resin chain modified with a glass/polyacid (as in compomer.) A more descriptive and accurate name for compomers is therefore poly-acid modified resin composites (PAMR.)[1] PAMR is defined asa subgroup of composites that contain a different type of hydrophilic monomer plus glass filler particles that release fluoride.[2] These behave even more like a typical resin composite in their physical properties. Generally, some significant properties such as strength, fluoride release and hydrophilic tendency may vary between the two types of materials, which can make a difference in choosing the best material for a particular clinical application.

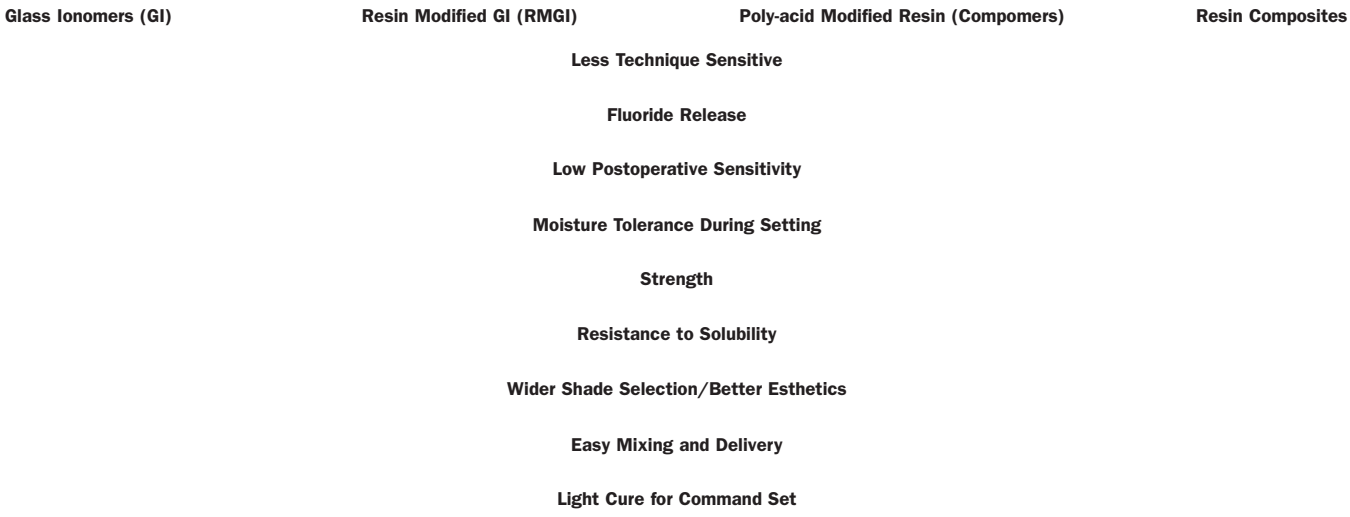
Table. **Advantages, Disadvantages of glass ionomers vs. resin composites.**

Advantages	
Glass Ionomers	**Resin Composites**
Direct adhesion to tooth structure without bonding Coefficient of thermal expansion similar to dentin Some remineralization possible	Much higher bond strengths to enamel (but more technique sensitive steps required)
Disadvantages	
Glass Ionomers	**Resin Composites**
Possible expansion due to water absorption (may not be recommended for use with all-ceramic restorations.)	Polymerization shrinkage

A true dual cured material can be achieved with a resin composite that contains both a photo-initiator as well as an auto-polymerizing reaction of the resin matrix. This also can be accomplished in an RMGI or PAMR as well if the resin polymerization reaction can be light activated to reach a command set providing immediate workability, while the auto-polymerizing reaction continues over some period of time. However in addition to this, any material that contains both a glass ionomer as well as a resin will have two different setting reactions occurring simultaneously (i.e., polymerization and an acid-base reaction.)

There may be some advantage to using a PAMR over a traditional resin composite in having a slightly greater hydrophilic tendency; but they are not as moisture tolerant as either GI or RMGI products. (However, sufficient isolation is important for all of these materials.) So they may be neither quite as strong as composites nor offer the same application advantages as GI or RMGI materials. In practice, it

Figure. **Characteristics of Restorative Materials.***



*** Darker shading indicates that the characteristic is more strongly associated with the material listed above.**

is very difficult to distinguish between RMGI and PAMR or between PAMR and resin composites, since there are no standards that specify the line of demarcation, and one must depend upon the manufacturer's classification.

Fluoride release: When and where does it make a difference; how much is enough?

Historically, glass ionomer materials were developed for their fluoride release, and virtually all of the products evaluated in this issue make that claim.* Although higher fluoride concentration and release is assumed to be better in product advertising, the actual clinical effect of fluoride release – whether in terms of absolute amount or rate of release over time – is not well established in preventing secondary caries. How important this effect might be in a given patient is a clinical judgment. Considering also secondary advantages of fluoride such as its short-term bacteriostatic properties, the ability of a product to release fluoride may provide a caries-reducing effect for tooth structure in immediate contact with the restoration. In vitro studies have demonstrated this, including the potential even to remineralize small carious lesions adjacent to GI restorations.[3,4] Glass ionomer restoratives also might serve as reservoirs that contribute fluoride ion to saliva for an overall low-dose topical application, so they could serve as a transitional source in high caries risk situations or where other water or topical application is absent. However, clinical studies have exhibited conflicting evidence as to whether or not these materials significantly prevent or inhibit secondary caries and affect the growth of caries-associated bacteria compared to non-fluoridated restoratives.[5-7] It appears to be far more important in preventing secondary caries to maintain effective hygiene, have a daily topical fluoride effect, and reduce the frequency of exposure to cariogenic foods.

* Two products featured in this report list release of ACP either in addition to fluoride or instead of fluoride. ACP, amorphous calcium phosphate, is a non-fluoride material developed and patented by Paffenbarger Research Center that has the potential to remineralize hard tissues and prevent secondary caries. See ADA News (August 20, 2007;38(15):1, 10).

Conclusions

The following general conclusions might be made in light of the clinical research available rather than relying on manufacturers' claims alone for indications of use. In the final analysis however, there is no single product recommendation that can substitute for the practitioner's clinical judgment and experience.

- Given the advantages of RMGI, the primary reason for selection of a pure glass ionomer product is probably when moisture control is limited, coupled with demands for maximum fluoride and direct ionic bonding to tooth structure without an additional, technique-sensitive step (e.g., Class V restoration with a subgingival margin, or ART technique in deciduous teeth of young children,[8] where complete isolation and enamel bonding with a resin bonding agent are difficult to accomplish.)
- Another possible reason for choosing a GI, applicable especially when used as a luting agent, is to minimize post-operative sensitivity.
- There seems to be fairly weak reasons for choosing a compomer product per se instead of a traditional resin composite where esthetics and strength are primary concerns. These should probably be compared to other composites (with the possible advantage of having some fluoride release or a bit more water tolerance.) A GI or RMGI might be a better choice where there are limitations on clinical technique and some therapeutic fluoride release is desired. Materials that are called "compomers" by the manufacturer, depending on the amount of resin vs. glass ionomer, either may be more comparable to a resin composite or an RMGI in its handling, bonding and strength characteristics. *(See product evaluation results in Restoratives report.)*

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Clarification

Rebec Simple Solutions has informed the PPR that although CatchHG 1000 does not have an intervention warning, a full separator canister will not affect vacuum function.

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