Shirley Gutkowski, RDH, BSDH

Blocking Biofilms With Glass Ionomer Sealants

Abstract

Sealants have proven to be a valuable preventive service. Changes to resin sealants have made them more reliable as a pit and fissure protectant that shields the most susceptible part of the tooth from decay and have a high sealant retention rate.

Glass ionomers used as a sealant have gone beyond the traditional retention of resin sealants. Glass ionomer cements have been enticing dentistry for a use as a sealant for a long time, and with good reason. Glass ionomers act as a fluoride reservoir, releasing fluoride for years. They also bond chemically to the tooth in a moist atmosphere, raising the bar of sealants' efficacy to a new level. This article reviews the history of glass ionomers as a sealant and surface protectant material.

Many articles have been written about dental sealants, and most clinicians know that sealants are a barrier to biofilms. The physical barrier blocks the biofilm formation in the pits and fissures, and it keeps the acids out of the fissures, prohibiting dental decay.[1] If the sealant is properly placed, the pits and fissures will be safe from further decay.[2] In the Third National Health and Nutrition Examination Survey analysis, pit and fissure decay accounted for 88% of caries while the occlusal surface accounts for only 13% of total tooth surface.[3] In the United States the percentage of children without caries experience in permanent teeth has doubled in the past 20 years.[4]

For a number of years, resin sealants have remained basically the same. Some innovations have developed in material or application, such as refined applicators and added colorants to make placement easier to see, such as the 3M™ ESPE™ Clinpro™ Sealant (St. Paul, Minn, www.3m.com). Ivoclar Vivadent's Helioseal® (Amherst, NY, www.ivoclarvivadent.us.com) has a system to make the resin sealant appear green when ultraviolet (UV) light is focused on the sealant after placement to make it obvious to the clinician that the sealant is still present.

Evolution in the sealant materials has allowed for improvement in the UV lights as well. Along with the advanced setting properties of the newer resin sealants, the Rembrandt® Sapphire® Light (Den-Mat Corporation, Santa Maria, Calif, www.denmat.com), ARC Light® IIM Xenon Curing and Bleaching System (Air Techniques, Inc. Hicksville, NY, www.airtechniques.com), and the Easy Cure 3 (Sullivan-Schein Dental®, www.sullivanschein.com) have better intensity to allow shorter setting times and deeper depth of cure. This increased speed makes it easier for the apprehensive patient to have a positive dental experience.

Isolation of the tooth is still one of the major difficulties in resin sealant placement. Hygienists are often charged with placing sealants without assistance, making placement difficult. The sealant position paper from the American Association of Pediatric Dentistry recommends using a bonding agent to increase the strength of the bond, particularly on the buccal and lingual surfaces.[3] This step decreased sealant failure by 47% on occlusal surfaces and reduced risk of failure by 65% on the buccal or lingual surfaces.[3] UltraSeal™ XT plus (Ultradent Products, Inc., South Jordan, Utah, www.ultradent.com) includes a separate bonding agent with their sealant. 3M ESPE makes a product that, although not intended for use with sealants, is an etchant and bonding agent in one, eliminating a step. Resin sealants' main function has been, and will always be, a physical barrier protecting pits and fissures.

Use and Overuse

Studies agree that placing sealants on teeth at high risk for decay increases sealant effectiveness.[3] That is to say, placing a sealant on a child with existing restorations or decay is far more beneficial than placing a sealant on a patient who has never experienced decay with low caries risk. The goals for Healthy People 2010 are to have sealants on 50% of children's teeth.[5]

A sweeping statement to seal all teeth is overstating the need. Insured populations with access to municipal water fluoridation have such a low incidence of decay that sealants may be considered overtreatment.[6] Dennison stated that sealants had an almost insignificant effect on population-based treatment or health care costs. Over 5 years, placement of 15 sealants eliminated the need for 1 restoration in the study population. The effective risk reduction for teeth receiving sealant was approximately 50% over 5 years.

After analyzing the cost/benefit ratio, the authors do not recommend routine sealants in this population. This does not reflect the needs of the rest of the population. For every child without medical insurance, there are 2.6 children without dental insurance and 38% do not live in communities with fluoridated water.[7]

Fluoride is still one of the best assets we have with regard to preventing decay. Low-dose, long-duration fluoride application, as in fluoridated municipal water supplies, has decreased the amount of decay.[8-11]

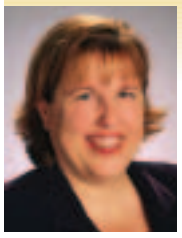
Risk

Most decay is in the pits and fissures; erupting molars are the highest risk, and second molars exhibit a 20% higher incidence of caries than first molars.[3,6,12] These statistics, plus poor nutrition, poor oral hygiene, ineffective salivary components, and insufficient saliva increase the risk for dental decay.[13] In some cases, resin sealants are not indicated because of the young age of the patient, the patient's inability to cooperate, or something as simple as an incomplete eruption. Even with these presentations, the risk for decay is often so high that clinicians may feel compelled to do something.

One option is fluoride varnish. However, varnish is not a barrier to biofilms or their waste products. Resin sealants are the first choice for sealing pits and fissures because they have been proven to provide mechanical defenses against decay-causing organisms and their waste products. In certain circumstances, such as insufficient eruption, glass ionomer sealants should be considered.[14] Glass ionomer cements obstruct biofilms, deliver fluoride, and have been studied extensively in sealant applications, so they are the best option in difficult cases.

Glass Ionomers as Sealants

A glass ionomer is a material that has many benefits as a sealant material, such as:



Shirley Gutkowski, RDH, BSDH

Shirley, a graduate of Marquette University, practiced full-time general dental hygiene in Madison, Wisc, from 1986 to 2003. A frequently published author, Shirley won the 2003 APEX award for writing a series on dental care for Diabetes Self-Management. She is active in the online dental hygienist community, is the chair of the 3M® ESPE® Dental Hygiene Advisory Panel, is the president of the Madison Area Dental Hygienists' Association, and works with Dental Hygiene Onsite. Shirley welcomes comments at Dentwrite@aol.com.

Learning Objectives

After reading this article, the reader should be able to:

- Learn what a surface protectant is.
- Discover the role that saliva plays in caries management.
- Learn the applications for glass ionomer sealants.

- therapeutic fluoride release.
- thermal expansion coefficient similar to enamel.
- chemical bond to the enamel.
- saliva friendly.
- self-curing.
- short-term bactericidal activity.[15]
- inhibits biofilm formation.[15-17]

Fluoride acts as a flux in the powder component of the glass ionomer, driving the chemical reaction between calcium, silicate (glass), and aluminum. Calcium and aluminum ions react with phosphoric acid, creating an aluminum-calcium-phosphate matrix that binds the partially reacted glass particles together.[14,16,18]

The fluoride is not a structural component of the matrix and is expendable without affecting the overall cement.[19] The fluorides are leached from the cement and have been shown to react with the enamel, forming a more acid-resistant zone and even resulting in remineralization.[18] This fluoride release is increased in an acidic environment.[19] Fluoride in a glass ionomer has been shown to buffer lactic acid.[16] This is important because glass ionomers are then proactive in the high-caries-risk individual. Placed in a high acid enviornment where demineralization of tooth structure is occuring, glass ionomers can chemically alter the acidity with the release of fluoride.

The fact that this material also contains and reacts with water is important because it forms a hydrogel. The hydrogel allows the most important benefits of glass ionomer to occur, which is fluoride rechargeability. As fluoride is leached out of the material into the surrounding tissue, fluoride is also allowed in from general daily homecare products, effectively creating a fluoride reservoir or battery.[18,19]

This hydrogel property is also what makes glass ionomer possible to place in a moist environment, even under an operculum in a partially erupted tooth, which is an area that is unsealable with traditional resin sealants.

Glass ionomer materials have evolved from cements and leuting agents to permanent restorations and currently to sealants. As a cement or leuting material, glass ionomers have a long history of providing excellent clinical results. The pathway for a permanent restoration and sealant material is much longer and convoluted.

Glass ionomers are brittle when compared with other restorative materials and wear away over time.[14] Studies have shown alarmingly short lifespans of glass ionomers as sealants.[20-22]

Over time, manufacturers have developed glass ionomers to withstand occlusal forces and to increase flowability. The caries rate was decreased substantially in teeth that were sealed with glass ionomer sealants, regardless of its presence.[22] Scanning electron microscope views showed that although the teeth had no sealant visible to the unaided eye, there was some material located deep in the pits and fissures, still providing a barrier to the fissure.[22] And the minute amount of glass ionomer sealant continually acted as a fluoride battery—discharging and recharging with fluoride as the environment allowed.

Other findings stated finger pressure to the material on the tooth increased retention.[22,23] The pressure increased the bond strength and forced the material into the fissures.

Table 1—Unstimulated and stimulated salivary pH and flow rate in patients with and without caries

	With caries	Without caries
Unstimulated salivary pH	6.55 +/- 0.07*	7.12 +/- 0.05
Stimulated salivary pH	6.72 +/- 0.09*	7.21 +/- 0.06
Unstimulated salivary flow (mL/min)	0.43 +/- 0.03*	0.73 +/-0.09
Stimulated salivary flow (mL/min)	0.60 +/- 0.05*	1.12 +/- 0.10

*Values are mean +/- SEM. *P<0.05.*

Establishing Sealant Efficacy

Sealant effectiveness comes from the idea that sealants act only as a physical barrier to decay-causing elements. Sealant studies that compared composite resin sealants with glass ionomer sealants found that glass ionomer sealants physically didn't last as long as resin sealants. These examinations were done with the unaided eye. The outcome at the end of the trials found that the decay rate for the teeth sealed with the glass ionomer sealants were less likely to have statistically less significant decay.[3,21,24]

Glass ionomers act as a physical barrier and they contain fluoride to interact chemically with the enamel, increasing its effectiveness as a sealant and providing a new way to determine sealants' effectiveness. Research by Pereira and colleagues found no need to reapply chipped glass ionomer sealants to affect caries rate.[20]

"Sealant effectiveness should be measured by a decrease in decay, not just retention of the sealant," says Dr. Hein Ngo. Dr. Ngo is an Australian dentist and developer of GC Fuji Triage™ (GC America, Inc. Alsip, Ill, www.gcamerica.com), the only glass ionomer to be marketed as a sealant (H Ngo, oral communication, September 2003). Triage has a distinct pink color to allow high-risk patients and clinicians to detect the material, even after curing. It has 6 times the fluoride release as other glass ionomer cements, and it can be used as a surface protectant on parts of the tooth other than the occlusal.

Objective analysis of a pit or fissure's fitness up until now has been established without magnification and with the use of only an explorer before placing a sealant. This lack of definitive information has propelled some clinicians to surgically alter the pit's or fissure's anatomy in an attempt to facilitate better sealant access and retention. It also has sometimes led to clinicians attempting to remove incipient decay, believing that this early decay should be removed for the sealant to be effective, but this is not the case.[24] Use of air abrasion, or fissureotomy burs, to open pits or fissures is not supported by the evidence.[3]

Newer techniques and technology for detecting decay, plus the mounting supporting evidence for use of digital x-rays (CDR®, Schick Technologies, Inc., Long Island City, NY, www.schicktech.com; DIGIPAN®, Trophy Radiologie, S.A., Danbury, Conn, www.trophy-imaging.com) and light (QLF™, Inspektor Research Systems bv, Amsterdam, the Netherlands, www.inspektor.nl; OMNII Oral Pharmaceuticals, West Palm Beach, Fla, www.omniipharma.com) or laser caries detection (KaVo

Table 2—Salivary buffering capacity in those with caries and those without

Buffering capacity	Caries,%	Without caries,%
Low	52	8
Medium	25	47
High	23	45

DIAGNOdent®, KaVo America, Lake Zurich, Ill, www.kavousa.com), make explorer examination inadequate. Clinicians left with only unassisted vision and an explorer use inadequate tools for detecting decay early enough and determining the true mineralization of the tooth. Or worse, they are creating a cavitated lesion from one that could have remineralized.[25,26]

Many authors have studied the effectiveness of placing composite resin sealants over incipient lesions and concluded that altering the tooth's surface is not necessary and leaving remnants of caries is inconsequential to the longevity of the resin or glass ionomer sealant.[3,21,24] As long as the decay hasn't penetrated through the enamel it is safe and recommended to seal it without amputation of the tooth.[3,27] The use of ozone therapy (HealOzone™, KaVo America) shows promise in further reducing the need for surgical intervention by sterilizing the tooth's surface.[28] The use of glass ionomer sealants has been known to remineralize damaged enamel.[27,29-30] The flow of fluoride through the hydrogel formulates fluoroapatite, which is less soluble than enamel without fluoride (hydroxyapatite) and heightens the importance of this material to modern dentistry in an attempt to practice minimally invasive dentistry.

Saliva

Children are the prime candidates for sealant application, although sealants should be used on teeth with pits and fissures, regardless of the patient's age.[3] Lack of saliva is not often considered for this age group. Any clinician who has attempted to place traditional composite resin sealants on an apprehensive child knows of the near hyperactivity of the salivary ducts once the surface has been cleaned.

Saliva is an important part of the demineralization/remineralization process of the tooth. Although saliva quantity is not often an issue with children, saliva quality can be.

As the dentition becomes carious, the salivary pH drops.[31] A low-pH beverage, such as carbonated soft drinks or fruit juice, coupled with ambient acidic saliva, tip the scale to favor continued demineralization. Sanchez and colleagues, in a paper describing the quality of saliva, showed that children with caries had smaller increments of salivary flow after stimulation with 1 of 4 test beverages (Coca-Cola®, Sprite®, Ades N [Brazilian beverage], and chocolate milk), and children without caries had nearly double the flow rate.[31] This team also showed that children with caries had lower salivary pH than the control group (Table 1).

Saliva in the children with caries had low buffering capacity when compared with the children without caries. Fifty-two percent of the children with decay had saliva with low buffering capacity, compared with only 8% of the children without

decay. Saliva with a high buffering capacity was nearly double in children without decay, compared with children with decay. These are tough problems to overcome with a toothbrush. The research team did not speculate which came first, low buffering capacity of saliva or caries. They did state that the flow rate was a predisposing intrinsic factor for developing decay (Table 2). Without a saliva test, a clinician cannot know a patient's saliva chemistry. Ivoclar Vivadent makes a saliva test (CRT® buffer) that can be administered chairside.

Bacteria counts have not proven to be as important an indicator as saliva quality.[31,32] Van Palenstein Helderman and colleagues found that while it was a part of the whole caries picture, bacterial counts are a single indicator of a multifactorial disease and knowing which bacteria grew out of the saliva was of little importance.[32] Freedman and Diefenderfer showed that an acidic environment released fluoride from the glass ionomer.[18]

Croll and Nicholson reported that glass ionomer acts as a buffer to lactic acid, increasing pH around the material within seconds of the acid challenge.[16] Carvalho and Bezerra found a statistically significant reduction in *Streptococcus mutans* in the children who had atraumatic restorative treatment (a process where decay is removed with hand instruments only) with glass ionomer.[33] Okuda and colleagues found inhibition zones around the glass ionomer restorations in that study.[34] Given this information on saliva, and the fact that glass ionomers can be placed in a moist environment, a clinician could be more motivated to place glass ionomer sealants on children with caries experience.

Plaque Quality

The biofilm known as plaque has a very bad reputation in dentistry. It is the root cause of all dental disease. Periodontal disease and decay are both brought about by the mass of pathogens conglomerating on the surfaces of the teeth.[35]

While it's difficult to say that plaque is our friend, it is not the enemy that we perceive. When it comes to decay, this biofilm can be a useful reservoir for the components we look for to remineralize teeth. Plaque can harbor fluoride, calcium, and phosphorous, thereby making the building blocks of enamel readily available to teeth.[8,36] Although brushing is important, leaving some plaque isn't horrible, as long as remineralization elements are provided by way of fluoride, such as lozenges (Lozi-Flur™, Dreir Pharmaceuticals, Inc., Scottsdale, Ariz, www.dreirpharmaceuticals.com) or dairy products (Recaldent™, Bonlac Foods Limited, Melbourne, Australia, www.recaldent.com).[10]

It's widely known in dental circles that plaque lives on sugars, or glucose. *S mutans* has the reputation of causing the most decay. In a study published in 2002, Bradshaw and his team studied the effects of fluoride on biofilm and planktonic microbial communities.[8] In the biofilms created, the team included only 4% *S mutans*. After feeding the cultures glucose for 10 days and allowing the pH to drop to levels preferred by acidophiles, the culture demographic changed dramatically, increasing the *S mutans* to nearly 23% from 4%.

When the study was repeated and the glucose was provided in the presence of sodium fluoride, the demographic balance of the bacterial colony did not change. The fluoride restricted the growth of *S mutans* to

<5%. They concluded that even low amounts of fluoride exert direct and indirect effects on the flora.

Glass ionomers have been shown to have an inhibitory effect on biofilm formation around the restoration for up to 3 months.[15] The glass ionomer buffers the acid with sodium fluoride release, blocks the pits and fissures, and can be placed in a moist field.

Conclusion

In the end, both intuitively and scientifically, sealants work. Glass ionomer sealants are not for everyone—they are for the difficult cases. They have a definite place in our armamentarium. GC Fuji Triage was developed specifically as a surface protectant. Dr. Ngo saw circumstances where all surfaces of the tooth should be protected against decay (H Ngo, oral communication, September 2003). In the case of dependent or infirm patients, or those at high risk for decay, GC Fuji Triage can be used on any at-risk tooth surface.

Early decay can be arrested and the tooth remineralized by applying glass ionomer to that surface and instructing the patient to watch for the pink color. When it's gone, in some cases it's time to reapply. In other cases, if the patient has overcome a physical handicap, diet, or the tooth is now fully erupted, the surface protectant may no longer be needed. Currently, studies tell us that glass ionomer can be expected to provide fluoride for 2 years to 5 years, as described by Croll and Nicholson and Forsten.[16,30]

The National Call to Action to Promote Oral Health urges us to "increase oral health workforce diversity, capacity, and flexibility."[37] Glass ionomers can help improve dental hygiene outreach results by acting as a sealant protecting pits and fissures, as well as a surface protectant on the broad surfaces of the tooth. COH

Disclosure

The author received an honorarium from GC America Corporation to write this article.

References

1. Yip HK, Smales RJ. Glass ionomer cements used as fissure sealants with atraumatic restorative treatment (ART) approach: review of literature. *Int Dent J*. 2002;52:67-70.
2. Weintraub JA. Pit and fissure sealants in high-caries-risk individuals. *J Dent Educ*. 2001;65:1084-1090.
3. Feigal RJ. The use of pit and fissure sealants. *Pediatr Dent*. 2002;24:415-422.
4. Brown LJ, Kaste LM, Selwitz RH, et al. Dental caries and sealant usage in US children, 1988-1991—selected findings from the Third National Health and Nutrition Examination Survey. *J Am Dent Assoc*. 1996;127:335-343.
5. Healthy People 2010 Information Access Project. Goals. Nov 2000. Available at: http://www.healthypeople.gov/Document/HTML/Volume2/21Oral.htm#_Toc489700401. Accessed Oct 3, 2003.
6. Dennison JB, Straffon LH, Smith RC. Effectiveness of sealant treatment over 5 years in an insured population. *J Am Dent Assoc*. 2000;131:597-605.
7. Oral Health 2000: Facts and Figures. Aug 2002. Available at: http://www.cdc.gov/OralHealth/factsheets/sgr2000-05.htm. Accessed Oct 3, 2003.
8. Bradshaw DJ, Marsh PD, Hodgson RJ, et al. Effects of glucose and fluoride on competition and metabolism within in vitro dental bacterial communities and biofilms. *Caries Res*. 2002;36:81-86.
9. Adair SM, Bowen WH, Burt BA, et al. Centers for Disease Control and Prevention. Morbidity and Mortality Weekly Report: Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States. Aug 2001. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5014a1.htm. Accessed Oct 3, 2003.
10. Riordan PJ. Fluoride supplements for young children: an analysis of the literature focusing on benefits and risks. *Comm Dent Oral Epidemiol*. 1999;27:72-83.
11. Featherstone JD. Prevention and reversal of dental caries: role of low level fluoride. *Comm Dent Oral Epidemiol*. 1999;27:31-40.
12. Kinsell Berger E. Molar eruption and glass ionomer sealants. *Cont Oral Hyg*. 2003;3:32-36.
13. Rethman J. Trends in preventive care: caries risk assessment and indications for sealants. *J Am Dent Assoc*. 2000;131:8S-12S.
14. Berg JH. Glass ionomer cements. *Pediatr Dent*. 2002;24:430-438.
15. Berg JH, Farrell JE, Brown LR. Class II glass ionomer/silver cermet restorations and their effect of interproximal growth of *Streptococci mutans*. *Pediatr Dent*. 1990;12:20-23.
16. Croll TP, Nicholson JW. Glass ionomer cements in pediatric dentistry: review of the literature. *Pediatr Dent*. 2002;24:423-429.
17. Nicholson JW, Aggarwal A, Czarnecka B, et al. The rate of change of pH of lactic acid exposed to glass ionomer dental cements. *Biomaterials*. 2000;21:1989-1993.
18. Ewoldsen N, Herwig L. Decay-inhibiting restorative materials: past and present. *Compend Contin Educ Dent*. 1998;19:981-984,986,988,992.
19. Freedman R, Diefenderfer KE. Effects of daily fluoride exposures on fluoride release by glass ionomer-based restoratives. *Oper Dent*. 2003;28:178-185.
20. Pereira AC, Pardi V, Basting RA, et al. Clinical evaluation of glass ionomers used as fissure sealants: 24-month results. *ASDC J Dent Child*. 2001;68:168-174.
21. Weerheijm KL, Kreulen CM, Gruythuysen RJ. Comparison of retentive qualities of 2 glass ionomer cements used as fissure sealants. *ASDC J Dent Child*. 1996;63:265-267.
22. Karlzen-Reuterving G, van Dijken JW. A 3-year follow-up glass ionomer cement and resin fissure sealants. *ASDC J Dent Child*. 1995;62:108-110.
23. Smales RJ, Gao W, Ho FT. In vitro evaluation of sealing pits and fissures with newer glass ionomer cements developed for the ART technique. *J Clin Pediatr Dent*. 1997;21:321-323.
24. Blackwood JA, Dilley DC, Roberts MW, et al. Evaluation of pumice, fissure enameloplasty, and air abrasion on sealant microleakage. *Pediatr Dent*. 2002;24:199-203.
25. Yassin OM. In vitro studies of the effect of a dental explorer on the formation of an artificial carious lesion. *ASDC J Dent Child*. 1995;62:111-117.
26. Lussi A, Megert B, Longbottom C, et al. Clinical performance of a laser fluorescence device for detection of occlusal caries lesions. *Eur J Oral Sci*. 2001;109:14-19.
27. Hassall DC, Mellor AC. The sealant restoration: indications, success, and clinical technique. *Br Dent J*. 2001;191:358-362.
28. Baysan A, Whiley RA, Lynch E. Antimicrobial effect of a novel ozone-generating device on micro-organisms associated with primary root carious lesions in vitro. *Caries Res*. 2000;34:498-501.
29. Forss H, Seppa L. Prevention of enamel demineralization adjacent to glass ionomer filling materials. *Scand J Dent Res*. 1990;98:173-178.
30. Forsten L. Short- and long-term fluoride release from glass ionomers and other fluoride-containing filling materials in vitro. *Scand J Dent Res*. 1990;98:179-185.
31. Sanchez GA, Fernandez de Preliasco MV. Salivary pH changes during soft drink consumption in children. *Int J Paediatr Dent*. 2003;13:251-257.
32. van Palenstein Helderman WH, Mikx FH, Van't Hof MA, et al. The value of salivary bacterial counts as a supplement to past caries experience as cares predictor in children. *Eur J Oral Sci*. 2001;109:312-315.
33. Caralho CK, Bezerra AC. Microbiological assessment of saliva from children subsequent to atraumatic restorative treatment (ART). *Inter J Paediatr Dent*. 2003;13:186-192.
34. Okuda M, Pereira PN, Nikaido T, et al. Evaluation of in vitro secondary caries using confocal laser scanning microscope and X-ray analytical microscope. *Am J Dent*. 2003;16:191-196.
35. Kerr NW. Dental pain and suffering prior to the advent of modern dentistry. *Br Dent J*. 1998;184:397-399.
36. Reynolds EC, Cai F, Shen P, et al. Retention in plaque and remineralization of enamel lesions by various forms of calcium in a mouthrinse or sugar-free chewing gum. *J Dent Res*. 2003;82:206-211.
37. Centers for Disease Control and Prevention. A National Call to Action to Promote Oral Health fact sheet. June 2003. Available at: http://www.cdc.gov/oralhealth/factsheets/call_to_action.htm. Accessed Oct 3, 2003.

CEQuiz

Instructions—*Contemporary Oral Hygiene* offers 2 Continuing Education (CE) credit hours per issue. To receive credit, record your answers on the enclosed answer sheet or submit them on a separate piece of paper. You may also phone your answers in to (888) 596-4605, or fax them to (703) 404-1801. Be sure to include your name, address, phone number, Social Security number, and method of payment. The deadline for submission of quizzes is 12 months after the date of publication. Participants must attain a score of 70% on each quiz to receive credit. To register, call (888) 596-4605. Participants are urged to contact their state registry boards for special CE requirements.

1. What is resin sealants' main function?
a. protecting pits only
b. protecting fissures only
c. protecting both pits and fissures
d. protecting gingiva

2. What increases the risk for dental decay?
a. poor nutrition
b. poor oral hygiene
c. ineffective salivary components and insufficient saliva
d. all of the above

3. What are some of the benefits of glass ionomer sealants?
a. therapeutic fluoride release
b. saliva friendly
c. self-curing
d. all of the above

4. Studies have shown alarmingly short lifespans of glass ionomers as sealants. Compared with other restorative materials, glass ionomers are:
a. brittle.
b. soft.
c. coarse.
d. dense.

5. What do glass ionomers contain to interact chemically with the enamel, increasing its effectiveness as a sealant?
a. fluoride
b. silicate
c. hydrogel
d. cement

6. What therapy shows promise in further reducing the need for surgical intervention by sterilizing the tooth's surface?
a. light therapy
b. periodontal therapy
c. ozone therapy
d. water therapy

7. Who are the prime candidates for sealant application?
a. children
b. senior citizens
c. adults between age 25 and 45
d. adults between age 35 and 55

8. What is often an issue with demineralization/remineralization with children's teeth?
a. saliva quantity
b. saliva quality
c. low buffering capacity
d. high buffering capacity

9. What is the root cause of all dental disease?
a. glucose
b. fluoride
c. phosphorous
d. plaque

10. Glass ionomers have been shown to have an inhibitory effect on biofilm formation around the restoration for up to:
a. 2 months.
b. 3 months.
c. 4 months.
d. 6 months.