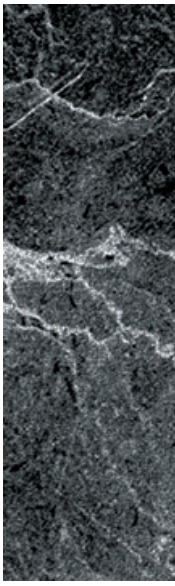

Critical Appraisal

PROTOCOL FOR THE PREVENTION AND MANAGEMENT OF ROOT CARIES

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This critical appraisal deviates from our standard format to address a timely topic of particular interest to clinicians.

As the baby boom generation matures, it is clear that the population of North America is aging. In the year 1900, only 3% of the population was over 60 years of age, whereas in 2000, 13% of the population was over 60 years old.[1] By 2030, it is estimated that at least 20% of the population will be 60 or older.

Root caries is a pervasive problem for a high percentage of elderly patients (Figures 1 and 2).[2,3] Many of these patients have received extensive restorative dentistry over their lifetime (Figure 3). Approximately 38% of patients between the ages of 55 and 64 have root caries, whereas 47% of those between 65 and 74 years have experienced root caries.[4] The incidence of root caries in old-old subjects (over 75 years of age) is even higher.[5]

One of the primary etiologic factors for these patients is their use of prescription drugs for a wide variety of systemic medical problems. It has been estimated that 63% of the 200 most commonly prescribed medications have a side effect of dry mouth.[6] The subsequent reduction in salivary flow rates and concomitant diminished buffering capacity resulting from use of these medications are primarily responsible for the increase in root caries in elderly patients.

The critical pH of dentin (pH at which dentin begins to demineralize) is 6.7, whereas that of enamel is about 5.2.[7] As a result, root dentin will demineralize in very weak acids, and root caries progresses at about twice the rate of coronal caries. Thus, it is critical that all elderly patients are given a thorough clinical and radiographic examination on a regular basis.

With all elderly patients, a caries risk assessment should be carried out. There are several ways to do this, but the past history of caries generally is the best indicator for future risk.[8–10] Patients with gingival recession, poor oral hygiene, a cariogenic diet, multiple restorations, multiple missing teeth, existing caries, who are taking xerogenic medications, or who have compromised salivary flow rates for any reason may be considered at high risk for root caries.

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DOI 10.1111/j.1708-8240.2008.00218.x

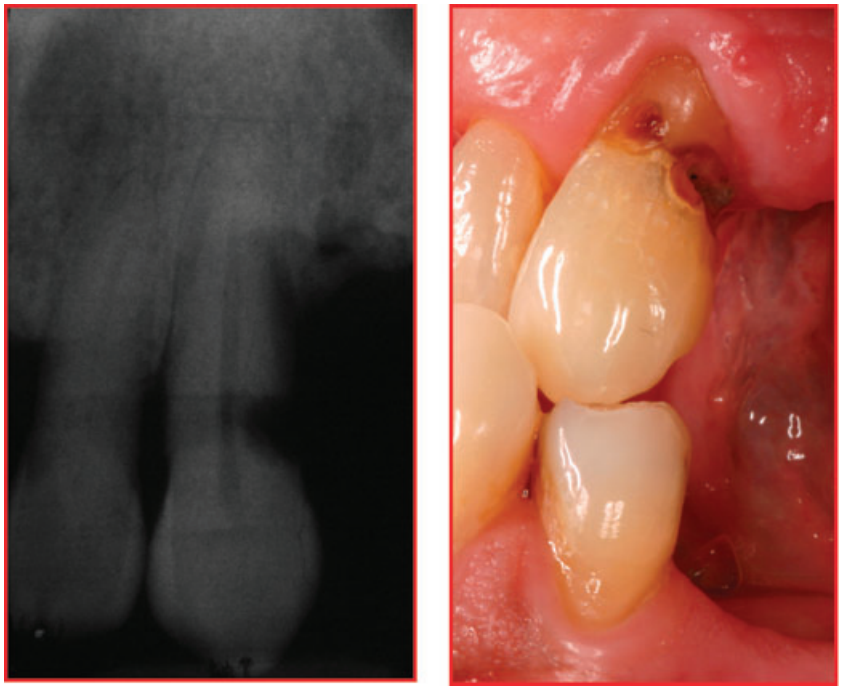

Figure 1. Radiographic and clinical appearance of root caries on tooth 11.

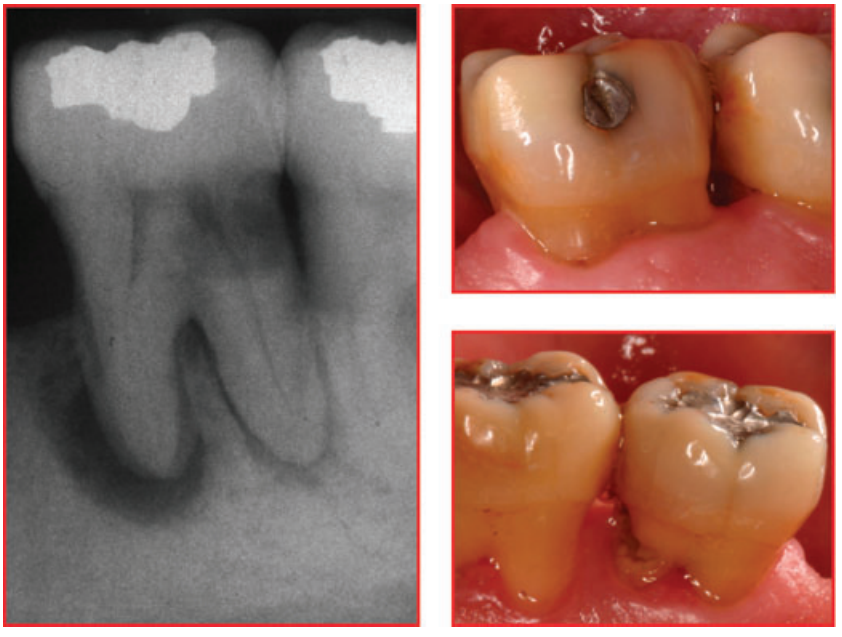

Figure 2. Radiographic and clinical presentation of root caries on tooth 19.

As soon as it has been determined that a patient is at high risk for root caries, an aggressive preventive protocol should be considered. This protocol is based upon four primary strategies for prevention of future root caries. The first strategy is to try to improve salivary flow rates and increase buffering capacity. The second strategy is to try to reduce the numbers of cariogenic bacteria (*Streptococcus mutans*) in the oral cavity.

The third strategy is to reduce the numbers of exposures and quantity of ingested refined carbohydrates. The fourth is to attempt to remineralize incipient lesions and prevent new lesions from developing. Many of the specific procedures that will be recommended could have an impact in multiple areas.

The following protocol is based upon these four primary strategies:

1. Perform an initial salivary evaluation:[11] one of the strategies to combat root caries is to attempt to improve salivary flow rates. Thus, it is important to obtain some baseline data prior to initiating the preventive protocol so that objective measurements can be taken over time to evaluate improvement. A kit is currently available that permits collection of saliva and will

Figure 3. Extreme root caries in a previously restored patient.

determine salivary consistency, resting and stimulated pH, stimulated flow rate, and buffering capacity (Saliva Check; GC America, Alsip, IL, USA). These data can be compared with benchmarks for xerostomia but more importantly can be used with similar data collected after implementation of the protocol to evaluate efficacy

2. Obtain an accurate list of the medications the patient is taking, along with the dosage and frequency: evaluate these medications for their xerogenic potential. In consultation with the patient's physician, it might be possible to prescribe fewer xerogenic medications, or to reduce the dosage. Changing the time of ingestion from evening to morning may be beneficial. Prescribing a salivary stimulant such as pilocarpine may be considered
3. Perform an initial microbiological evaluation: studies have determined that the primary etiologic agent in root caries is *S. mutans*.[12] It is critical to reduce high levels of *S. mutans* in susceptible patients. When the caries risk assessment determines that a patient has a moderate to high risk for caries, an initial screening test should be made. A relatively simple device that measures the amount of adenosine triphosphate (ATP) in the saliva is available (CariScreen; Oral BioTech, Albany, OR, USA). The amount of ATP in the saliva roughly correlates with the numbers of *S. mutans*, and the test can be accomplished in about a minute. Further bacterial culturing can be done for those with high ATP levels using an inexpensive culturing system (CariCult; Oral BioTech). Use of such objective data can also be quite motivational for patients, as they can readily see positive results if their scores improve. More information on these relatively new products can be obtained at http://www.carifree.com
4. Gross carious lesions should be excavated as quickly as possible and restored with a fast-setting, self-cure glass ionomer restorative material (e.g., Fuji IX; GC America): it is not essential at this stage to completely remove all caries, just remove the bulk of the leathery caries and seal the lesion. This procedure significantly reduces the numbers of *S. mutans* in the oral cavity
5. Prescribe a 0.12% chlorhexidine gluconate mouth rinse (e.g., Peridex; 3M Omni, St. Paul, MN, USA): patients should be instructed to do a 30-second (by the clock) rinse twice a day. Chlorhexidine is a powerful plaque-reducing agent and will quickly reduce the numbers of microorganisms in the mouth. This should be done for a period of 2 weeks and should be followed

TABLE 1. FLUORIDE VARNISHES (5% NaF).

Product	Manufacturer
All Solutions	Dentsply Professional (York, PA, USA)
CariFree	Oral BioTech (Albany, OR, USA)
Cavity Shield	3M Omni (St. Paul, MN, USA)
Duraflor D2	Medicam (Montreal, Quebec, Canada)
Duraflor Halo	Medicam (Montreal, Quebec, Canada)
Duraphat	Colgate Pharmaceuticals (New York, NY, USA)
Durashield	Sultan Healthcare (Englewood, NJ, USA)
Eclipse	Massco Dental (Gravette, AR, USA)
Enamel Pro	Premier Dental (Plymouth Meeting, PA, USA)
Flor-Opal	Ultradent Products Inc (South Jordan, UT, USA)
Fluorilaq	Pascal Co. Inc. (Bellevue, WA, USA)
FluoroDose	Centrix Incorporated (Shelton, CT, USA)
Iris	Benco Dental (Wilkes-Barre, PA, USA)
Kolorz Clear Shield	Zenith Dental (Englewood, NJ, USA)
PreviDent Varnish	Colgate Pharmaceuticals (New York, NY, USA)
Vanish	3M Omni (St. Paul, MN, USA)
Varnish	Keystone Industries (Cherry Hill, NJ, USA)
Varnish America Original	Medical Products Laboratories, Inc (Philadelphia, PA, USA)
Varnish America White	Medical Products Laboratories, Inc (Philadelphia, PA, USA)

by another test for ATP levels. If levels are significantly reduced, use of the chlorhexidine rinse can be discontinued. Side effects of chlorhexidine are staining and taste alteration

6. Apply 5% sodium-fluoride (NaF) varnish to all exposed root surfaces, and repeat this procedure every 3 months: fluoride varnish has well-documented efficacy and does NOT require patient compliance.[13] See Table 1 for a list of available 5% NaF varnishes. Fluoride varnish will reduce the numbers of bacteria and also works by promoting remineralization of tooth structure
7. Prescribe a sodium lauryl sulfate (SLS)-free prescription fluoride toothpaste (e.g., Prevident 5,000 Dry Mouth; Colgate Pharmaceuticals, New York, NY, USA). Patients should be instructed to use this three times per day. SLS provides a detergent-like action to toothpastes. However, some studies have shown that it interferes with the plaque-reducing effect of chlorhexidine.[14,15] The recommended prescription toothpaste does not contain SLS and thus prevents the potential negative interaction
8. Ask the patient to complete a 4-day diet record: the patient should write down everything he or she ingests, the amount and the time for 4 days, with two of those days being on the weekend.[16] This should be analyzed for the amount of refined carbohydrates. One major culprit for patients with dry mouth is flavored candy such as breath mints. Dietary recommendations should be made that eliminate or reduce refined carbohydrates. Sugar-free breath mints are highly recommended, as they tend to increase salivary flow rates and are not cariogenic
9. Suggest that the patient use an automated toothbrush (Ultreo Ultrasound Toothbrush—Ultreo, Inc., Redmond, WA, USA; Triumph Sonic Toothbrush—Oral-B, South Boston, MA, USA; Sonicare Sonic Toothbrush—Philips Oral Healthcare Inc., Snoqualmie, WA, USA): it is critical that patients susceptible to root caries practice meticulous oral hygiene. However, many of these patients have physical and visual deficiencies that make it difficult for them to adequately cleanse the mouth. For these patients, an

TABLE 2. PRODUCTS CONTAINING XYLITOL.

Product name and manufacturer	Product type
Dr. Collins All White Whitening Toothpaste (Dr. Collins Dental)	Toothpaste
Rain Dry Mouth Spray: Xlear Inc. (Orem, UT, USA)	Mouth spray
Biotène Products: Laclede Inc. (Rancho Dominguez, CA, USA)	Gum, toothpaste, moisturizing sprays, and gels
BreathRx Halispheres (BreathRx, Culver City, CA, USA)	Gum
Supersmile Professional Whitening Gum (Supersmile, NY, NY, USA)	Gum
Trident, Trident White (Cadbury-Adams USA, Parsippany, NJ, USA)	Gum (several flavors)
3M Omni Products: 3M-ESPE (St. Paul, MN, USA)	Mouthspray, mints, gum
Peelu Dental Chewing Gum (Peelu USA, Fargo, ND, USA)	Gum
Ice Cubes, Ice Breakers: Hershey's (Hershey, PA, USA)	Candies
Epic Gum: Epic Dental (Provo, UT, USA)	Gum (several flavors)
Xylifloss: ProCare Ltd. (Hameenlinna, Finland)	Dental floss

automated toothbrush might be advantageous. Preliminary studies indicate that the ultrasound toothbrush cleanses at an even greater distance than the sonic tooth brushes. If the patient can do it, daily use of a water irrigation device (Waterpik; Water Pik Inc., Fort Collins, CO, USA) is useful. Although it will not remove plaque, studies have shown that daily use will change the composition of the plaque in a beneficial way

10. Instruct the patient to use xylitol chewing gum three times a day (5 minutes after each meal) for at least 5 minutes each time: this gum should be chewed after meals, as it has been shown that that is when salivary pH is lowest. Xylitol has a strong evidence base and works by increasing salivary flow rates, causing a mutation of *S. mutans* to a less cariogenic form, and also assists in remineralization.[4] Table 2 lists some common xylitol-containing products. Xylitol is provided in a number of different products, including chewing gum, toothpaste, mints, candies, mouth sprays, and gels, and is even incorporated in dental floss. The Internet is a good source for purchasing xylitol products and one site that features a wide variety of products is http://www.Dentist.net
11. Instruct the patient to apply amorphous calcium phosphate (MI Paste, GC America) with the finger to all exposed root surfaces prior to going to bed at night. This paste contains both calcium and phosphate and helps remineralize the tooth surface
12. Restore all root caries lesions with a fluoride-releasing material: Table 3 lists some currently available products. All Fuji IX restorations should be removed and all active caries removed. Resin-modified glass ionomer materials are preferred primarily because they bond effectively to both enamel and dentin, and they act as reservoirs for fluoride

TABLE 3. RESIN-MODIFIED GLASS IONOMER RESTORATIVE MATERIALS.

Material	Manufacturer	Dispensed as
Vitremer	3M-ESPE (St. Paul, MN)	Powder/liquid
Ketac-Nano	3M-ESPE	Paste/paste
Fuji II LC	GC America (Alsip, IL, USA)	Powder/liquid
Fuji Filling LC	GC America	Paste/paste

that can be rereleased into the oral cavity.[17,18] They are effective as anticaries materials only if patients recharge the material at least three times/day by brushing with a fluoride-containing toothpaste or using other fluoride-containing products. Educating patients about the necessity of three fluoride exposures per day to recharge the fluoride-releasing materials can assist in motivating them to improve levels of compliance

13. Patients should be placed on a strict three-month recall where fluoride varnish will be applied after prophylaxis, and salivary and bacterial tests can be repeated as necessary

In summary, many elderly patients are experiencing an epidemic of root caries, primarily as a result of the xerogenic side effects of medications prescribed for systemic illnesses. Many root caries lesions occur in locations that make them difficult, if not impossible, to restore. The dental profession has a strong track record of prevention, and it is clear that with root caries, prevention is much better than restoration.

This article presents a clear protocol, based on contemporary clinical evidence, that can prevent the ravages of root caries.

THE BOTTOM LINE

North America's population is aging rapidly and is experiencing an epidemic of root caries. Many root caries lesions are difficult, if not impossible to restore, so prevention is preferable to treatment.

A caries risk assessment should be completed for all elderly patients, and those patients found to be at moderate to high risk for root caries should receive an aggressive preventive protocol. This protocol includes four specific overlapping strategies: to increase salivary flow rates and the buffering capacity of saliva; to reduce the numbers of *S. mutans* in the oral cavity; to reduce the quantity and number of exposures to refined carbohydrates; and to attempt to tilt the demineralization–remineralization equation in favor of remineralization.

There is no silver bullet with root caries. Every modality available should be used. With motivated, compliant patients, the protocol described in this appraisal has proven to be very effective in the prevention and management of root caries.

REFERENCES

1. Shay K. The evolving impact of aging America on dental practice. J Contemp Dent Pract 2004;15:101–10.
2. Leake JL. Clinical decision-making for caries management in root surfaces. J Dent Educ 2001;65:1147–53.
3. Thomson WM. Dental caries experience in older people over time: What can the large cohort studies tell us? Br Dent J 2004;196:89–92.
4. Winston AE, Bhaskar SN. Caries prevention in the 21st century. J Am Dent Assoc 1998;129:1579–87.
5. Berkey DB, Berg RG, Ettinger RL, et al. The old-old dental patient: The challenge of clinical decision-making. J Am Dent Assoc 1996;127:321–32.
6. Screebny LM, Schwartz SS. A reference guide to drugs and dry mouth: 2nd edition. Gerodontology 1997;14:33–47.

7. Surmount PA, Martens LC. Root surface caries: An update. Clin Prev Dent 1989;11:14–20.

8. Morris DW. Caries risk assessment: using the medical model of care for prevention and intervention. Contemp Oral Hyg 2006;6:26–31.

9. Chalmers JM. Minimal intervention in dentistry: Part I. Strategies for addressing the new caries challenge in older patients. J Can Dent Assoc 2006;72:427–31.

10. Allen AY, McNally ME, Fure S, Birkhed D. Assessment of caries risk in elderly patients using the Cariogram model. J Can Dent Assoc 2006;72:459–65.

11. Navazesh M. How can oral health care providers determine if patients have dry mouth? J Am Dent Assoc 2003;134:613–8.

12. Zambon JJ, Kasprzak SA. The microbiology and histopathology of human root caries. Am J Dent 1995;8:322–8.

13. American Dental Association Council on Scientific Affairs. Professionally applied topical fluoride: Evidence based clinical recommendations. J Am Dent Assoc 2006;137:1151–9.

14. Barkvoll P, Rolla G, Svendsen AK. Interaction between chlorhexidine gluconate and sodium lauryl sulphate in vivo. J Clin Periodontol 1989;16:593–5.

15. Owens J, Addy M, Faulkner J, et al. A short-term clinical study design to investigate the chemical plaque inhibitory properties of mouthrinses when used as adjuncts to toothpastes: Applied to chlorhexidine. J Clin Periodontol 1997;24:32–7.

16. Kidd EA. The use of diet analysis and advice in the management of dental caries in adult patients. Oper Dent 1995;20:86–93.

17. Burgess JO, Gallo JR. Treating root-surface caries. Dent Clin North Am 2002;46:385–404.

18. Haveman CW, Redding SW. Dental management and treatment of xerostomic patients. Texas Dent J 1998;115:43–56.