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Endodontic Techniques

for Scouting the Apical Thirds

of Root Canals





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How Sweet It Isn't



An old saying admonishes one to believe nothing that you hear and only half of what you read. Hyperbole is not always the best means to educate or live, but frequently is effective in making a point. As dentists, we should constantly question that which is anecdotal and not supported by scientific evidence; but we have an advantage in that we are taught to do so.

Unfortunately, the public is not as aware of the need to consider what is put before them as we are. Billions of dollars are spent in marketing and advertising to the masses to get them to purchase a product or service. Not always is the advertising scientifically valid or even factual. The undiscerning public has to make choices based on what they hear on the radio or see on television and in newspapers and magazines.

There is an escalating battle going on, at first in the press, and more recently in the courts between the sugar trade association and the manufacturers of artificial sweeteners or sugar substitutes, particularly McNeil Nutritionals who produce Splenda. The complaint of Big Sugar is that Splenda is misleading the public by using the tag line "made from sugar, so it tastes like sugar." Not surprisingly, this charge is levied at the same time the association is seeing a decline in sales. In 2003, sales were down 1.8 percent and in 2004, 4.3 percent.¹ At the same time, Splenda sales went from \$65 million in 2001 to a 50 percent market share with \$346 million in 2004. Considering that in 2004, the sugar market was \$911 million

and the artificial sweetener market was \$343 million, it is obvious there are serious dollars at stake.²

Sugar has consistently maintained a strong lobby and manages to minimize or eliminate foreign competition. Twenty-two million dollars in contributions to campaigns in the past 15 years have been documented. Government price controls, trade agreements and loan guarantees have allowed the cost of sugar in this country to be 2½ times the world price. That amounts to \$2.5 billion in additional cost for products to manufacturers and the consumer.³ This is big business.

Artificial sweeteners or sugar substitutes have been on the market for more than 50 years. Products such as Sweet'N Low (based on saccharin) that were developed in the 1950s, as well as Equal and NutraSweet (both aspartame derivatives) introduced in the 1970s, were created to help diabetics and obese patients. Given our penchant for thinness, they caught on and became major players in the sweetener market. In the 1980s, the sugar association began to realize there was a problem with its diminishing market share.²

Splenda, generically known as sucralose, is an artificially manufactured sweetener. It is derived from sucrose and chemically altered to replace some hydroxyl radicals with chlorine and was approved by the Food and Drug Administration in 1998. The body does not recognize it as a



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sugar and does not metabolize it as such. The taste, while subjective, has been shown to be acceptable given the rapidly increasing sales.

The FDA announced in May 2005 that sucralose does not promote tooth decay.⁴ Other studies have confirmed this.⁵ We can be comfortable in advocating the use of this and similar products in our patients. There have been numerous websites — and we all understand the reliability of an unmonitored or unfiltered website — that have promoted the nonuse of sucralose as a result of laboratory studies that showed harmful effects. Compare this with the scares of many years ago with saccharin and cyclamates killing lab rats.

The use of artificial sweeteners appears to have a positive health effect with no documented significant drawbacks. The sugar market is diminishing on a regular basis; and by the end of the 20th century, the use of high-fructose corn syrup, saccharin, aspartame and sucralose had taken over 70 percent of what was the sugar market in past years.

As professionals, we are aware of the harmful effects of sugar, locally in the promotion of dental caries or systemically in many ways. We have advocated sugar intake reduction in children and adults throughout our careers. To our patients' benefit, there have been numerous sugar substitutes available for consumption directly and in the manufacture of sugar-containing products.

Big Sugar is trying to scare consumers out of buying products made with sucralose. This is not science and should not be the rationale for any purchases. It is easy to understand how large trade associations are motivated toward profits and not public safety or efficacy of their product.

Is sucralose the answer to all sugar-related disorders? Probably not, but as dentists we can be comfortable that from a dental caries standpoint it is much sweeter to consider than sugar.

Think about it ... the whole fuss is over a campaign slogan. We see the product is safe given the millions of uses without incident. We know that it reduces or minimizes dental diseases. The consumers are telling us that the taste is better than other artificial sweeteners by increasing consumption. Related industries (e.g., baking, soft drink) are putting the sucralose in their product; and the sugar industry, which can do nothing to change their product, is hurting.

It remains to be seen who will prevail in the courts. But isn't the publicity of this matter worth millions in advertising to the Splenda company? As health professionals, we should be in favor of Splenda, not as a specific product, but for the direct and indirect health benefits. It remains to be seen if levelheaded science prevails or if the political and financial clout of an industry (whose time may be over) will triumph. If Big Sugar is successful in its lawsuits, the Splenda company will have to change its advertising slogan. That will have marginal effects on the sales of the product that is enjoying ever-increasing popularity so it will be a bittersweet victory for the sugar people. **CDA**

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Comments, letters, and questions can be addressed to the editor at alan.felsenfeld@cda.org.

Solutions for Licensure

I now submit the letter I have been writing in my mind for a decade, and it is written from the perspective of a dentist who has just retired after 41 years of practice.

First, if one graduates from an accredited school of dentistry in the United States, he or she has done so by the recommendation of the school and the faculty, and has passed the national boards — he or she is now a dentist. Further clinical evaluation, public protection mumbo-jumbo and so-called state boards are unnecessary and an embarrassment to the profession of dentistry. Dentistry needs to come into the 21st century and shut down all seemingly good intention discussion in this arena.

Now for foreign-trained dentists. The solution is simple, and the model already

exists with our medical colleagues. Simply require the candidate to pass the written national boards and complete a dental residency of some type. A problem solved.

I suggest the mentioned solutions will place the responsibility for the quality and competency of dentist where it should be, namely, the dental schools. By the way, under this program one can now see complete reciprocity among the states. All other postdoctoral testing prior to licensure, live patients, mannequins or clinical manipulations are a remnant of yesterday's dentistry and have no place in this honorable profession. Continuing education requirements would nicely fill any perceived voids.

Reese McClenny, Jr., DDS
Bakersfield, Calif.

Further clinical evaluation, public protection mumbo-jumbo and so-called state boards are unnecessary and an embarrassment to the profession of dentistry.



Illustration: Matt Mullin

Milestone Reached in Genetic Compilation

For nearly two decades, the three leading public repositories for DNA and RNA sequence data have collaborated to provide access to the ever-increasing amount of genetic data produced by institutions around the globe. The three repositories have now reached a significant milestone by collecting and disseminating 100 gigabases of sequence data. For a frame of refer-

ence, 100 billion bases is about equal to the number of nerve cells in a human brain and a bit less than the number of stars in the Milky Way.

These bases, or "letters" of the genetic code, represent both individual genes and partial and complete genomes of more than 165,000 organisms, according to a National Library of Medicine news release. While a single gene from organ-



**"It is important
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information."**

—TAKASHI GOJOBORI

isms as diverse as apple trees, bacteria, earthworms, elephants, fruitflies, and humans can range from less than 100 to more than several thousand bases long, an organism's genome can be longer than 1 billion bases. The free access to this information allows scientists to study and compare the same data as their colleagues nearly anywhere in the world, and makes possible collaborative research that may ultimately lead to cures for diseases and improved health.

Thanks to their data exchange policy, the three members of the International Nucleotide Sequence Database Collaboration, GenBank in Bethesda, Md.; European Molecular Biology Laboratory's European Bioinformatics Institute, EMBL-Bank in Hinxton, United Kingdom; and the DNA Data Bank of Japan in Mishima, Japan, all reached this milestone together.

GenBank is maintained by the National Center for Biotechnology Information, a part of the National Library of Medicine, National Institutes of Health. Submitters to GenBank currently contribute more than 3 million new DNA sequences per month to the database.

"Today's nucleotide sequence databases allow researchers to share completed genomes, the genetic makeup of entire ecosystems, and sequences associated with patents," said David Lipman, director of the National Center for Biotechnology Information. "The International Nucleotide Sequence Database Collaboration (INSDC) has realized the vision of the researchers who initiated the sequence database projects by making the global sharing of nucleotide sequence information possible."

Graham Cameron, associate director of EMBL's European Bioinformatics Institute, added, "This is an important milestone in the history of the nucleotide sequence databases. From the first EMBL Data Library entry made available in 1982 to today's provision of over 55 million sequence entries from at least 200,000 different organisms, these resources have

anticipated the needs of molecular biologists and addressed them — often in the face of a serious lack of resources."

While much has changed since the days when sequences were manually keyed in from the literature or sent on floppy disc and distributed to users on nine-track magnetic tapes, the purpose of the databases — to make every nucleotide sequence in the public domain freely available to the scientific community as rapidly as possible — remains as strong now as it did then.

Takashi Gojobori, director of the Center for Information Biology and DNA Data Bank of Japan, said: "The INSDC has laid the foundations for the exchange of many types of biological information. As we enter the era of systems biology and researchers begin to exchange complex types of information such as the results of experiments that measure the activities of thousands of genes, or computational models of entire processes, it is important to celebrate the achievements of the three databases that pioneered the open exchange of biological information."

The National Center for Biotechnology Information is part of the National Library of Medicine. Established in 1988 as a national resource for molecular biology information, NCBI creates public databases, conducts research in computational biology, develops software tools for analyzing genome data, and disseminates biomedical information all for the better understanding of molecular processes affecting human health and disease. NCBI is host to the GenBank nucleotide sequence database.

The National Library of Medicine, the world's largest library of the health sciences, is a component of the National Institutes of Health, U.S. Department of Health and Human Services.

For more information online, go to <http://www.ebi.ac.uk/emb> for EMBL-Bank; <http://www.ddbj.nig.ac.jp/> about DNA Data Bank of Japan; and <http://www.ncbi.nlm.nih.gov> for GenBank on the NCBI website.

Cavity-Causing Medications Not What the Dentist Ordered

While a spoonful of sugar helps the medicine go down, most dentists likely encourage parents to skip that step when treating a child's illness. This is because most parents are not aware some children's medicines can cause cavities, according to a report in an issue of *General Dentistry*, the Academy of General Dentistry's clinical, peer-reviewed journal.

Antihistamine syrups frequently are purchased over-the-counter or prescribed for treating the typical illnesses or chronic allergies. However, many of these syrups contain low pH levels and high acidity, which can be an unsavory recipe for a child's teeth. The sugar in the medicine, combined with the acids, dissolve dental enamel, causing erosion.

The report revealed that placing children's teeth in contact with syrupy medications could cause erosion to the outer layers of the teeth. However, when treated with a topical fluoride remedy, the decay was minimal.

"Although some medications are necessary for general health, they can be extremely harmful to the teeth if the



medicine is given at bedtime, or without following proper oral health habits," said Carolina Covolo da Costa, DDS, MSc, author of the study.

Since nature's buffer against cavities — saliva — decreases during the night, medications given before bed can do a great deal of damage if a child does not brush away the acids and sugar. A fluoride toothpaste can provide extra protection against decay. If brushing is not possible, rinsing the mouth with water can help minimize the risk.

Tips for Giving Medication

- Give the medication at meal times instead of bedtime.

- Have the child rinse with water or chew sugar-free gum afterward.

- Have the child take calcium supplements or use a topical fluoride after using. (The parent should check with the child's pediatrician or dentist before giving any supplements.)

Overall Health May Determine Dental Implant Success

Dental implants have become the treatment of choice for some patients to eliminate the need for removable partial or complete dentures. Other patients choose implants to conserve tooth structure or for esthetic purposes in an otherwise cavity-free mouth.

But according to a recent report in the issue of *General Dentistry*, the Academy of General Dentistry's clinical, peer-reviewed journal, the failure or success of an implant relies on a number of factors, including the quality of the patient's overall health.

Chronic problems such as tooth clenching and grinding, or systemic diseases such as uncontrolled diabetes can decrease the success rate for implants in individuals with such problems. Also, individuals who smoke heavily or abuse alcohol may not be ideal candidates for the procedure.

"You must have good bone quality and a lack of chronic periodontal disease for the implant to stay in place," said lead author Judith A. Porter, DDS, MA, EdD. "Patients are unaware that bone loss in their jaw will often follow the loss of a tooth. When that happens, over time, bone loss can cause facial changes and diet changes."



Photograph: Ray Olson

Correction

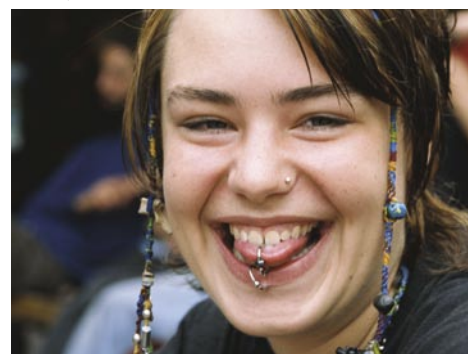
In the Impressions section of the December 2005 *CDA Journal*, Leon Assael, DDS, professor at the Oregon Health and Science University School of Dentistry, was misquoted. The information available for use in the Impressions section was incorrect. Bisphosphonates produces bone destruction.

Holey Practice Presents Health Complications

Oral piercing is as old as civilization, but its increasing prevalence today means dentists should be aware of the complications, risks, and dental implications frequently associated with such procedures, said Jennifer Choe, DDS; Khalid Almas, BDS, MSc; and Robert Schoor, DDS, in the fall 2005 issue of *The New York State Dental Journal*.

The report recounted a treatment plan, using a case study involving a 26-year-old male patient with localized gingival recession and inflammation associated with tooth No. 25, directly opposite a tongue stud. The authors believed their findings “strongly implicate the piercing as the primary factor in this localized traumatic periodontitis.”

They presented a list of possible adverse consequences and common complications from oral piercing, including oral pain, disease transmission, edema, infection, airway obstruction secondary to swelling, chipped or fractured teeth, prolonged



bleeding, mucosal or gingival trauma, interference with mastication and swallowing, speech impediment, hyypersalivation, hyperplastic or scar tissue formation, nerve damage and paraesthesia, aspiration of specific piercing jewelry, and foreign body incorporation.

“The patient in this case report represents a situation that will occur more frequently as the popularity of tongue piercing increases,” the authors said.

Classifying Injuries from Blasts

Acknowledging that dentists’ role in aiding people hurt in terrorist attacks likely is reserved for immediate triage, a group of physicians published a review in the *New England Journal of Medicine* discussing the characteristics of contemporary explosive devices and the spectrum of injuries inflicted by explosions and blasts. The authors noted that bomb attacks require triage according to the model of “urgent, immediate, delayed, minimal, or expectant care.”

The authors, led by Ralph DePalma, MD, named four types of blast injuries: primary, secondary, tertiary and quaternary.

Primary blast injuries are caused by barotraumas, either underpressurization or overpressurization relative to atmospheric pressure. Primary blast injuries most commonly involve rupture of the tympanic membrane, damage to the respiratory system and damage to the colon or, less frequently, the small intestine. Eyes, too, are susceptible to damage from excessive atmospheric pressure. Because the ear-



drum can be affected by atmospheric pressure, the authors noted its condition could help health care professionals determine the extent of the blast and the likelihood of further internal damage.

Secondary blast injuries are penetrating injuries from fragments (either as a result of the blast or as part of the weapon). Penetrating injuries are the leading cause of death in both civilian and military terrorist attacks.

Tertiary blast injuries are those caused by structural collapse following an explosion, leading to blunt or crushing trauma.

Finally, quaternary blast injuries refer to illnesses, injuries, and diseases related to the initial blast. These can range from toxic inhalation, burns, exposure to radiation, asphyxiation and inhalation of dust containing asbestos or coal.



Honoring Volunteers Abroad

The deadline to nominate individuals for the Certificate of Recognition for Volunteer Service in a Foreign Country is March 31.

The ADA Committee on International Programs and Development is accepting nominations for dentists and dental students who have spent at least 14 days in a two-year period performing dental services in a foreign land. Nominations must be submitted by a state or local dental society, the federal dental service, or a dental school.

For more information or to obtain an application, contact the ADA Center for International Development and Affairs via e-mail, international@ada.org, or call (800) 621-8099, Ext. 2726.

Dentists Who Treat Kids Can Play a Role in Fighting Obesity

Pediatric dentists have an important role in fighting the recent upswing in childhood obesity, and their role should stem from the dentist's concern for their patient's overall health, said William Vann, DMD, MS, PhD; Jessica Lee, DMD, MPH, PhD; Thomas Bouwens, and Antonio Braithwaite in *Pediatric Dentistry*.

In the article, the authors urged pediatric dentists to heighten their staffs' awareness by relying on the recently adopted American Academy of Pediatric Dentistry Policy on Dietary Recommendations for Infants, Children, and Adolescents.

"This AAPD policy is most timely and relevant for young children," the authors wrote, citing new evidence that "the first three years of life may lay the groundwork for obesity. In short, the nutritional risk assessment that is integral to the age 1 dental visit may offer health benefits far beyond those related to caries prevention."



Upcoming Meetings 2006

March 1-6	American Academy of Dental Practice Administration annual meeting, Dana Point, Calif., (800) 689-7515.
March 10	Pacific Coast Society of Orthodontists Central Regional Meeting, San Ramon, (415) 441-4697.
March 15-18	Academy of Laser Dentistry's 13th Annual Conference and Exhibition, Tucson, www.source2006.org .
March 26-April 1	United States Dental Tennis Association Spring Meeting, St. Petersburg, Fla., www.dentaltennis.org .
April 27-30	CDA Spring Session, Anaheim, (866) CDA-MEMBER (232-6362).
May 16-20	American Academy of Cosmetic Dentistry 22nd Annual Scientific Session, San Diego, (800) 543-9220.
May 22-27	Academy of Prosthodontics 88th Annual Scientific Session, San Francisco, www.academyprosthodontics.org .
Sept. 15-17	CDA Fall Session, San Francisco, (866) CDA-MEMBER (232-6362).
Oct. 16-19	ADA Annual Session, Las Vegas, (312) 440-2500.
Dec. 3-6	International Workshop of the International Cleft Lip and Palate Foundation, Chennai, India, (91) 44-24331696.

To have an event included on this list of nonprofit association meetings, please send the information to Upcoming Meetings, *CDA Journal*, 1201 K St., 16th Floor, Sacramento, CA 95814 or fax the information to (916) 554-5962.

Endodontic Techniques for Scouting the Apical Thirds of Root Canals

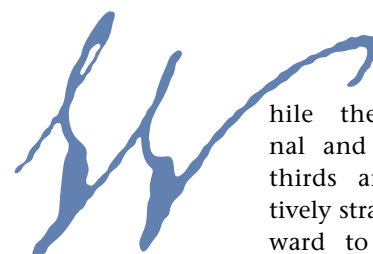


Richard E. Mounce, DDS

Abstract

It might be said that there are as many endodontic instrumentation techniques as there are operators, although no two clinicians perform the procedure in exactly the same manner. Despite differences, there are basic principles (correct diagnosis, adequate access, adequate irrigation, removal of the entire pulp, instrumentation to the minor constriction of the apical foramen, three-dimensional obturation, etc.) whose observance are consistent with long-term endodontic success. As a subset of these time-honored principles, there are guidelines and techniques for apical third “scouting” and instrumentation, which can also be considered universal, irrespective of the particular instruments or technique used for canal preparation.

The purpose of this paper is to describe a scouting technique that is designed to optimize the apical part of root canal preparation. The author first heard the word “scouting” used in the context described by Dr. Clifford J. Ruddle.



While the coronal and middle thirds are relatively straightforward to instrument, the apical third is certainly the most challenging portion of root canal anatomy to cleanse shape and obturate adequately. Managing the apical third might be thought of as one of the last steps in a process, which began with coronal access. Like an ascent of Mt. Everest, which starts many months before the final summit push in its planning, scouting and subsequent instrumentation of the apical third is the final result of the many smaller steps that preceded it and whose quality is dependent on those previous actions.

It is noteworthy that many “short” obturations and “calcified” canals are in fact, simply underprepared. Such underpreparation results from a lack of understanding of the anatomy present



Author / Richard E. Mounce, DDS, is in private endodontic practice in Portland, Ore. He lectures worldwide and has written numerous articles for journals.

Acknowledgements / Thank you to Dr. Gary Carr, The Digital Office Program for Endodontists, the Pacific Endodontic Research Foundation and Excellence in Endodontics II, and Dr. Arnaldo Castellucci for the images Figures 1 and 3.

Disclosure / The author receives honorarium when he lectures for SybronEndo and has no other commercial relationships of any kind.



Figure 1a.

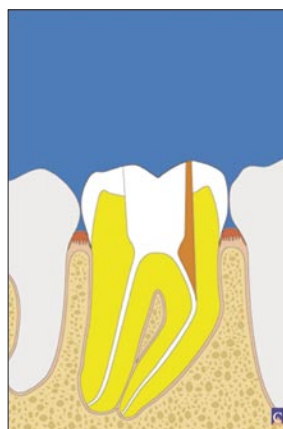


Figure 1b.

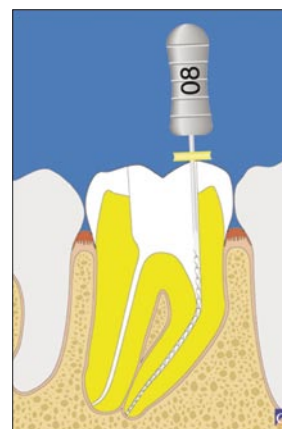


Figure 1c.

Figures 1a-c. Straight line access is essential to avoid iatrogenic events and have tactile control over files apically.

and the delicacy and care with which this complex and fragile region must be addressed.^{1,2} Advancing up the file sizes too quickly (hand or rotary) with excessive force, filing without an estimated or confirmed true working length, compacting pulp and dentin into the narrowing cross-sectional diameters of the canal, and losing apical patency amongst other misadventures, all preclude proper cleansing and shaping, and predispose to an increasing failure rate and iatrogenic misadventure. It is ill advised to be in the apical third with a rotary file without having first "scouted" the canal, established true working length, and/or created a glide path as will be described. Scouting provides an essential understanding of the existing anatomy within a root and provides, along with radiographs, a mental and tactile road map to the canal.

Preliminary Steps

Excellent management of the apical third is predicated on assumptions, which make up the needed previous stages mentioned prior. These assumptions are:

- Before any instruments are placed into the apical third (and before access is made) that there are multiple radiographic images of the tooth to give the operator the best 3-D picture of a space, which must be felt and cannot be seen. Various angles can also fully determine if there is a widened periodontal ligament or periapical lesion and fully give the clinician a reliable estimate of the

length of the root before beginning.

- Straight line access is also important for creating optimal control of the hand and rotary instruments, which will subsequently be placed into the apical third. Straight line access can prevent iatrogenic furcal perforation, ledging and instrument separation accentuated by the deflection of instruments against the walls of the coronal access (Figures 1a-c).

- Crown down instrumentation, which facilitates optimal apical third shaping. Removal of restrictive dentin in the coronal and middle third of root canal systems before entering the apical third allows a greater volume and exchange of irrigation as well as provides a much greater level of tactile control to the operator over the files. In essence, files placed into the apical third (with the upper two-thirds of the canal pre-enlarged) can more fully provide the operator with the ability to detect abrupt canal curvatures, narrowing cross-sectional diameters and the exact location, length and shape of the apical foramen. With the enhanced tapered (.08, .10, .12 taper-fixed tip size 25) K3 body shapers (SybronEndo, Orange, Calif.) which act as orifice openers, it is possible in many cases to instrument the coronal and middle thirds often with a single instrument. Irrespective of the rotary file system used though, in general terms, on average, 25 tip sized .06 tapered instruments should be used

to the junction of the middle and apical third at which point, the apical third is ready for scouting.

- Avoidance of dentinal shavings and pulverized pulp being compacted into the apical third in the initial stages of treatment, which can be prevented by copious irrigation as well as the placement of EDTA in a gel form to emulsify the pulp in coronal and middle third instrumentation, especially in vital teeth. Copious irrigation with sodium hypochlorite (ideally 5.25 percent) is essential, as is the presence of a viscous chelator (RC Prep, Premier Dental Products (Plymouth Meeting, Penn.) and Glide (Dentsply Tulsa Dental, Tulsa Okla.) in vital cases.^{3,4}

Scouting Technique

With the previous assumptions and precautions exercised, the clinician is ready to scout the apical third. Initially, a pre "J" curved K file 6-10, canal size dependent, is placed into the canal in the direction of the apical curvature determined radiographically. The Endo Bender pliers (SybronEndo, Orange, Calif.) (Figure 2) is ideal for creating this apical "J" curve in the file. The file is advanced gently in the canal with the intent to discover as much tactile information about the canal as possible and advanced only as far as the canal will accept without forcing the file to a preconceived length. Scouting requires a determined mental focus on the tac-



Figure 2. “J” file created with the EndoBender pliers (SybronEndo, Orange, Calif.).

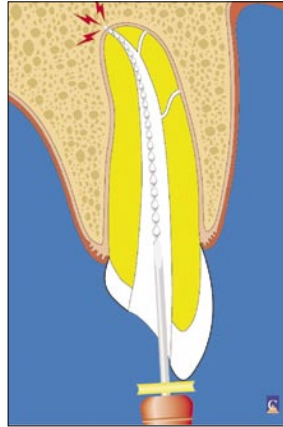


Figure 3. Apical patency demonstrated.

tile sensations that the canal reveals. Usually, in most canals, this size of a K file will be easily accepted (except in the most narrow and calcified cases). When the file reaches the actual apical foramen, which should match fairly

closely to the estimated working length determined preoperatively, the operator may perceive a “pop” or a “push” as the file exits the apical foramen. It is important to note the length at which this sensation is observed as this is the

true working length and represents the minor constriction of the apical foramen (**Figure 3**). This length should be identical to the reading given by an apex locator and that determined radiographically and/or determined by a bleeding or moisture point after instrumentation is completed.

If the operator is beginning with a 6-10 K file and can reach the estimated working length, it is advisable to then gently advance each subsequent file to the same length until a 10 or 15 K file reaches the same depth and an electronic apex locator reading should be taken as well as a radiograph from at least two angles to confidently determine true working length.

Exploration with the 6-10 K files should be unhurried, gentle and reproducible. In other words, the files should be placed back into the canal in the



Figure 4. Completed case demonstrating the principles described.

same orientation each time. If the 10 K file will spin loosely at the estimated true working length, then it is time to advance to the 15 K file. If the 6-10 K file will not advance the same way every time, it is possible the file has traversed down a different aspect of the

canal anatomy (i.e. another portal of exit or canal branch) than the original orientation. It may take multiple insertions of the 6-10 K files to reach the estimated length. Irrigation is copious and frequent, after every file. When the operator is using the files, and the full, estimated length of the canal has been reached, the file should be removed in a straight coronal direction, which will minimize the possibility of foramen transportation. In other words, when scouting files reach the estimated or true working length, they should not be rotated so as to not cut at the foramen.

A 15 K file, which spins freely at the true working length, has created a "glide path" for subsequent rotary files. Next, a .02 tapered 15 tip size K3 (SybronEndo, Orange, Calif.) can be placed to the true working length, which will accentuate the

glide path and fully refine the path for the rotary instruments that will subsequently finish the preparation. Generally, a .02 20 K3 can follow the 15 easily to true working length and completion of the canal preparation via a rotary method (irrespective of the file used) can be performed easily. The author prefers the .02 K3 for glide path refinement to other file brands due to its fracture resistance, cutting ability and easy tracking of the canal.

Coincident with this entire process, it is important the operator be certain to achieve and maintain apical patency. In other words, once a file will exit the apical foramen, it is important that the path through the foramen be maintained during the scouting process and final instrumentation, but not be enlarged. Achievement and maintenance of apical patency minimizes the creation and accumulation of dentin mud and minimizes the chance for ledging and perforation (Figure 4).

From this platform of scouting and glide path creation, it is then possible to fully instrument the apical third ideally either by hand or by rotary files. It must be borne in mind there are certain canals, which cannot be instrumented with rotary files and must be finished by hand, especially those with abrupt apical curvatures, merging canal systems, recurvatures, etc. It is a matter of clinical judgment to appreciate when such a root presents itself. **CDA**

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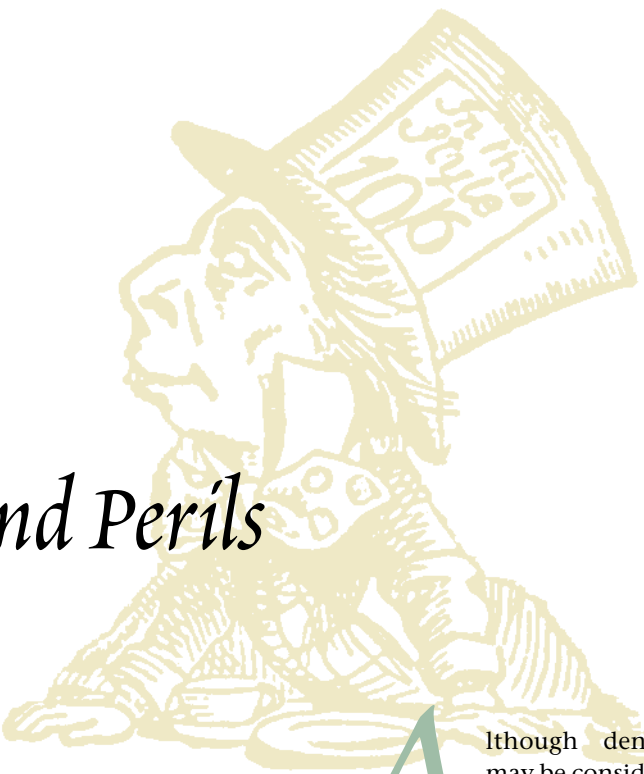
AMALGAM:

Its History and Perils

J.M. Hyson, Jr., DDS, MS, MA

Abstract

The current amalgam issue is not new. In the 1840s, there was even an “amalgam war” between the dentists who advocated the use of gold as a restorative material and those who used silver amalgam as a filling material. There were complaints of the ill effects of mercury in the amalgam as a health problem. The split on this issue threatened to divide dentistry into two camps: those who used amalgam and those who condemned it. The first national dental society in the United States, the American Society of Dental Surgeons, had to disband because of the controversy. There was even a “New Departure” movement in the 1880s to eliminate gold as a restorative material in badly broken down teeth, which could be more readily salvaged by the use of material that did not require the force of condensation needed to pack a gold foil, then considered the ultimate restorative material. However, amalgam has proven to be an excellent restorative material with few side effects — amalgam saves teeth.



Although dental amalgam may be considered a relatively new material, compared to gold, in the dental armamentarium, it appeared in the Chinese materia medica of Su Kung back in 659 A.D. during the Tang Dynasty. In Europe, Johannes Stockerus, a municipal physician in Ulm, Germany, recommended amalgam as a filling material in 1528.¹

Mercury, one of the key ingredients of dental amalgam, had first been described by Aristotle in 4th century B.C. as “liquid silver.” Five centuries later, Dioscorides, a Greek physician, used it as an eye medicine, but warned it was dangerous if swallowed. In the 18th century, John Hill, an Englishman, described mercury as, “It penetrates the substance of all metals, and dissolves, and makes them brittle.” Workers in the felt hat industry dipped furs into a mercuric nitrate solution to make them pliable, and in the process inhaled the mercury vapor. This process resulted in “tremors, loss of teeth, difficulty on walking, and mental disability.” The mad hatter of Lewis Carroll’s *Alice’s Adventures in Wonderland* (Figure 1) was probably patterned after such a victim.²

In 1805, W.H. Pepys and Joseph Fox of England first introduced “fusible

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Figure 1. Mad Hatter from *Alice's Adventures in Wonderland* by Lewis Carroll (courtesy of Bramhall House, Division of Clarkson N. Potter, Inc., N.Y.).

DENTAL SURGERY.
ATTENDANCE IN NEW YORK, DAILY, (SUNDAYS EXCEPTED,) AT 52 HUDSON STREET,
OPPOSITE JAY STREET.

ROYAL MINERAL SUCCEDANEUM.
For filling decayed Teeth without the slightest Pain, Heat or Pressure—and incorrodible MINERAL TEETH, fixed without Wires, Springs, or any other Ligatures.

MESSIEURS CRAWCOUR, of the firm of *Monsieur C. Crawcour & Sons*, established for more than a century, of Bond street, Piccadilly, Brunswick House, Commercial Road, London: and 5, South East Circus Place, Edinburgh; *Surgeon Dentists* to the Royal Families of England and France, patronized also by His Most Gracious Majesty, King William IV, the Courts of Austria, France, Russia, Prussia and Belgium.

GRATEFUL for the high and EXTENSIVE PATRONAGE which has so eminently distinguished their professional exertions since their arrival in the American Metropolis, beg leave to announce to their friends and the public, that they still CONTINUE to RESTORE DECAYED TEETH, however large or small the cavity, with their CELEBRATED ROYAL MINERAL SUCCEDANEUM, so universally recommended by the Facul-

Figure 2. Crawcour's advertisement (courtesy of the Samuel D. Harris National Museum of Dentistry).

metals" for filling cavities; however, the heat required to melt the material was obviously objectionable. In 1818, Louis Nicolas Regnart, a Parisian physician who devoted himself to dentistry, overcame this problem by the addition of one-tenth by weight of mercury; and, in this manner, amalgam (an alloy of mercury with another metal or metals, from the French word *amalgame*, reportedly derived from the Latin *malagma*, meaning a "soft mass") was invented. In 1826, Auguste Taveau of Paris used a "silver paste" made from filings of five French franc pieces mixed with mercury. The silver coins also contained tin and a small amount of copper, which gave the mixture more plasticity and a quicker setting time. In 1837, J.L. Murphy of London stated he had used amalgam for 12 years.³

The Crawcour Brothers: Royal Mineral Succedaneum

The Crawcours were a family of five Polish dentists who acquired a "superficial knowledge" of dentistry in France before unleashing themselves on the English public in the 1780s. They advertised extensively, proclaiming their skill and claimed to be surgeon-dentists to the "royal family and

patronized by the courts of Austria, France, Russia, Prussia, and Belgium."⁴ In 1833, two of the Crawcour brothers invaded the United States with a cheap coin silver amalgam they called "royal mineral succedaneum" (Figure 2). The Crawcours set up lavish and elegant dental "parlours" in New York City and competed with the ethical dentists. With the "grace and mannerisms of the French," they catered to the wealthy and influential residents of the city. The patients reclined on sumptuous easy chairs, and their dentistry was painless since they merely sloped and thumbed a soft plastic mix of their impure material into cavities without removing the decay. They were out-and-out money-grabbing charlatans who exploited the public, charging exorbitant fees. As the Crawcours' business boomed, the conscientious practitioners, who were still working with gold and tin, lost patients. Later, as the brothers' fillings began to fall out, discolor the teeth, and cause tooth fracture because of the cheap amalgam's expansion, the public realized it had been cheated. With that, the brothers beat a hasty retreat in 1834 back to Europe, leaving "a long trail of victimized patients and exasperated

dentists."¹ However, the damage had been done — amalgam now had a bad reputation, despite the fact that if used properly, it would later prove to be an excellent restorative material.⁵

The Amalgam War: 1841-1855

The so-called "Amalgam War" raged from 1840 to 1855, "broke up friendships and, even threatened to disrupt the profession."¹ In 1841, the American Society of Dental Surgeons, which had been founded the year before as the first national dental society in the United States (it gave the first honorary doctor of dental surgery degree), appointed a committee to study the amalgam problem. The committee, consisting of Drs. Eleazar Parmly, Elisha Baker, Solyman Brown, Chapin A. Harris, and Jahiel Parmly, reported that all filling materials, in which mercury was an ingredient, were "hurtful both to the teeth and every part of the mouth, and that there was no tooth in which caries in it could be arrested, and the organ rendered serviceable by being filled, in which gold could not be employed."⁶ Two years later, without even testing silver amalgam, their derogatory report resulted in the society's blanket state-

ment that “the use of amalgam constitutes malpractice.”² On the other hand, Dr. Christopher S. Brewster of Paris thought that to condemn the use of amalgam in all cases merely because its use was abused by some “unprincipled quacks” was unwise. He felt that “much good has been and may be done by a judicious use of this composition.”⁷ In 1842, Harris warned that there were few cases in which the “filling of teeth with an amalgam of mercury and silver, is justifiable.” He believed that amalgam exerted “a vitiating influence upon the fluids of the mouth and given rise to an unhealthy action in the gums.”⁸

The same year, a case of “ptyalism” following the insertion of amalgam filling in several large cavities was reported. The patient’s gums began to “inflamm and swell,” followed by an “increased flow of saliva, inflammation of the mucous membrane,” “soreness and loosening” of the teeth, and “feter of the breath, anorexy, and all the other symptoms attendant upon a mercurial diathesis of the system.”⁹ On 1844, Dr. Amos Westcott of Syracuse, N.Y., published a lengthy report on amalgam for the *American Journal of Dental Science*. He stated that “salivation” was a common complaint, the “oxyd” formed on the outer surface of the fillings was “easily carried into the stomach,” and that amalgam was “destructive to gold fillings and plate.” He concluded that the bad effects of mercury precluded its use by the dental practitioner in all cases.¹⁰ In 1844, Parmly of New York stated that “gold is the only substance known that can be permanently relied upon.”¹¹ Even in 1844, some dentists advocated removing amalgam fillings and replacing them with gold. Dr. S. M. Shepherd of Petersburg, Va., reported finding decay under one patient’s amalgam fillings and even though there were no symptoms, he replaced them with gold.¹²

In 1844, the society’s members were warned that they were to sign a pledge never to use amalgam or they would risk being expelled from the member-

ship. Many members resigned; and by 1847, only five of New York’s 200 dentists remained in the society, which Dr. Charles C. Allen said had “gold” for its motto.³

Another incident in 1847 cast an unfavorable light on amalgam with

the death of a Massachusetts man, a Mr. Ames, reportedly, according to the newspapers, “killed by bad dentistry.” In 1840, Ames was reported by his Parisian physicians as “thoroughly salivated, and without doubt from the



Figure 3. J. Foster Flagg (courtesy of the American Dental Association).

cement in his teeth." Before his death later in 1847, his American physicians disclaimed amalgam's role (it had been removed earlier) by stating that it had "no agency in causing his disease."¹³

Many dentists felt that the mercury in amalgam was a poison capable of "producing grave and lasting disturbances of health."¹⁴ On the other hand, Dr. Elisha Townsend reported in 1855 that two amalgam fillings he had inserted in 1834 were still "as good as when filled." Although he did not think it would ever supersede gold, he felt that some cases it was in the best interest of the patient to save the tooth using amalgam rather than gold, which required "heavy pressure for consolidation." Townsend even gave his personal directions for preparing the amalgam, known as "Townsend's Amalgam."¹⁵ In a special meeting of the Pennsylvania Association of Dental Surgeons held in October 1855, Townsend, the association's president, reiterated his views on amalgam that "a plastic material" was invaluable. He stated, "I am not a prodigy, and I do often see teeth my patient will thank me for saving, even if for a few months, which I have not the skill to fill with gold."¹⁶ Townsend said that he had seen hundreds of amalgam fillings and had never

seen "any injurious systemic effect."¹⁷ In 1858, Townsend reversed his stance on amalgam and recommended removal of teeth that could not be saved by gold.¹⁸

The same year, a case of amalgam fillings being blamed for "an affliction of the eyes" was reported in the *American Dental Review*. The patient's vision cleared up upon the removal of two silver fillings.¹⁹ In addition, amalgam was blamed for a patient's tendency to catch cold, an "eczematous" facial eruption, and facial neuralgia.²⁰ However, so much bitterness was created over the amalgam issue that eventually the society rescinded the amalgam pledge, but the damage had been done, and the organization folded in 1856, all because of the amalgam controversy.³

J. Foster Flagg: Amalgam Advocate

In 1855, Dr. J. Foster Flagg (1828-1903), professor of dental pathology and therapeutics at the Philadelphia College of Dental Surgery (Figure 3), began testing different amalgam formulas for posterior restorations. Flagg modified the popular formula of 60 percent tin to 40 percent silver by reversing it to 60 percent silver and 40 percent tin, and added combinations of other metals, e.g. copper, zinc, antimony, gold, cadmium, and platinum.^{11,21} In 1861, he presented his findings to the Pennsylvania Association of Dental Surgeons. In 1881, he published his book, *Plastic and Plastic Fillings* (Figure 4), as amalgam fillings were then popularly referred to as "plastic fillings." The inevitable result of this affair was that silver amalgam was proven to be "an excellent filling material" and expanded dentistry's "ability to save teeth."²²

Meanwhile, in 1859, M. Gershrine developed a new copper amalgam, which was rendered soft by heating to about 675 degrees, then triturating in an iron mortar, and heated to 225 degrees until it became soft.²² Although copper amalgam was used up until the

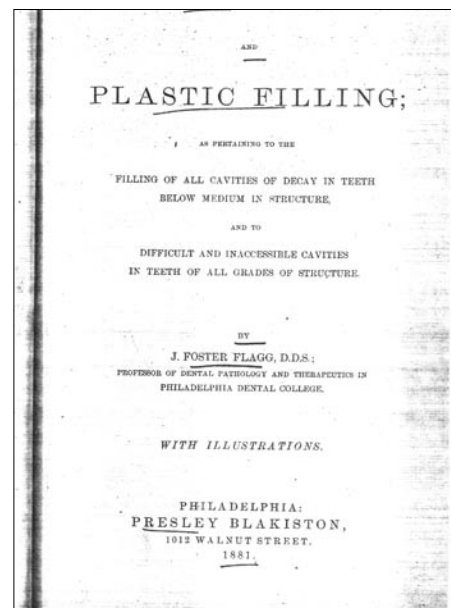


Figure 4. *Plastics and Plastic Fillings* (1881) by J. Foster Flagg (courtesy of the Dr. Samuel D. Harris National Museum of Dentistry).

1950s for pediatric restorations, by the 1970s, dentists were advised to avoid heating it.²³

Amalgam in the 1860s: St. Louis Odontological Society

During the American Civil War, the debate on the merits of amalgam continued. In 1861, Dr. John Tomes and his son, Charles, in England studied and conducted important experiments testing the expansion and contraction of the various amalgam products.²⁴ In April 1861, at the meeting of the Pennsylvania Association of Dental Surgeons, the subject of "amalgam" was the first topic on the agenda. It was argued that "the fault was not in the material but in the manipulation." Flagg stated that "the mission of the true dentist is not merely to be able to put in a solid gold filling, regardless of consequences, but to operate in such a manner as would best subserve the interest of the patient." He did not use amalgam in anterior teeth as he believed "the preservation of their beauty" was as essential as preserving

them for mastication. Flagg also noted that his friend, Dr. James E. Garretson (father of oral surgery), had suggested adding zinc chloride to the mixture and then washing with water.²⁵ At the Brooklyn Dental Association's meeting in October 1864, it was recorded: "Some men's amalgam is good universally, and some men's gold is bad universally; the difference lies in the preparation of the tooth and in the plug (filling)"; however, the "slovenly manner of preparing and using the material" was condemned in unqualified terms.²⁶ Many amalgam failures were blamed on them having been "put in over the decay."²⁷ Then too was the fact that the medical profession was against the use of mercury in restorations.²⁸ Finally, as early as 1867, the St. Louis Odontological Society unanimously adopted a resolution to the effect that amalgam was "injurious and detrimental to health" and that its members would discontinue its use.²⁹ The same year, a 15-year-old girl, who suffered from "inflamed eyes," had three teeth filled with amalgam extracted on the orders of her oculist, "They must come out." However, the disease was neither "palliated nor cured."³⁰

Amalgam in the 1870s: "The New Departure"

In August 1871, at the 11th annual meeting of the American Dental Association held at Niagara Falls, N.Y., Dr. E.A. Bogue gave a report on operative dentistry, which discussed the expansion and contraction of amalgam. Bogue urged the dental profession to know the composition of any remedies it employed, whether it be "patent medicine or amalgam fillings."³¹ The same year, the mercury in amalgam was blamed for causing a "rash breaking out" on a patient's face when she ate oysters.³² The following year, 1872, an amalgam filling was reported as the cause of death of a Nebraska middle-aged man. His

physicians thought, "The filling had salivated the unfortunate man, and as the inside of his mouth, throat and windpipe swelled, respiration was hindered, and it finally ceased altogether."³³

Since the involved tooth was a mandibular second molar, it is more likely that the patient died from diffuse submaxillary cellulites or as it is more popularly called, "Ludwig's Angina," rather than mercury poisoning.³⁴ Another case of "pytalism" causing headache, fever, rapid pulse, metallic taste, loss of appetite, and generalized malaise was reported in 1872 in a female patient following the insertion of eight amalgam fillings. However, the examining dentist said that the fillings had washed away, and that upon

*One of the most frequently asked questions
was whether amalgam should be washed and dried
before insertion into the cavity.*

probing, the metal crumbled away into fragments. He removed them all with an explorer in three minutes; therefore, the workmanship was shoddy and could have explained the patient's symptoms.³⁵

One of the earliest dentists to speak out against the use of amalgam in 1874, and probably the most radical, was Dr. J. Payne, who claimed the dental profession was poisoning "thousands of people all over the world from corrosive sublimate generated in the mouth from amalgam plugs in the teeth." He claimed the "quick-silver in the plugs is driven off by the heat in the mouth in very minute particles, and, combining with the chlorine in the fluids of the mouth, or any saline substance, such as our food, passed into the stomach, and produces slow poisoning." Payne wanted Congress to pass an act "making it a penitentiary offense to place any poisonous substance in teeth that will injure the people."³⁶

In rebuttal, *Dental Cosmos* commented that although it was true that temperatures of 300 degrees to 400 degrees a combination of chlorine and volatil-

ized mercury could produce corrosive sublimate, it was highly unlikely it happened in the mouth.³⁷ However, one dentist, W.R. Hayes of Dyersburg, Tenn., apparently took Payne's advice to heart and announced he was removing all the amalgam fillings in his patients' mouths and replacing them with gold. He thought the "golden gain" motivated the amalgam users.³⁸ One of the most frequently asked questions was whether amalgam should be washed and dried before insertion into the cavity. Dr. Thomas Burgh recommended washing it with soap and water, followed by plunging it into alcohol, and then expressing the excess mercury.³⁹ However in 1874, E.A. Bogue, MD, who had conducted experiments on amalgam, at a special meeting of the New York Odontological Society, stated, "It will be seen that, if almost any amalgam is used intelligently, teeth can be filled

so as not only to preserve them, but to do so without danger to the general health, from any element of the filling, unless it be copper."⁴⁰

In the late 1870s, a new trend called the "new departure" came into popularity, which signified "total abstinence from the use of gold."⁴¹ Flagg was given credit for the creed because of a paper he read at the meeting of the Odontological Society of New York on Nov. 20, 1877.⁴² The "new departure" considered gold the "worst material" and amalgam an "excellent filling material." Furthermore, "the use of 'plastic' filling material tends to lower that dentistry, which has for its standard of excellence 'ability' to make good gold fillings, but very much extends the sphere of usefulness of that dentistry, which has for its standard of excellence 'ability to save teeth'."⁴³ Dr. Henry S. Chase of St. Louis endorsed Flagg's conclusions that gutta-percha, tin, and amalgam fillings were superior to gold.⁴⁴

However, there was still reluctance by some dentists to endorse amalgam as safe. In 1878, the *Canada Lancet* said,

Figure 5. Greene Vardiman Black (courtesy of Mrs. Elizabeth Hubert Malott).



"The constitutional effects of mercury are too well known to require mention, and there can be no good reason for its use at all aside from its facility of introduction. The introduction of so virulent a poison into the system, even in any form, renders it possible for it to be absorbed in the slow way above indicated, is radically wrong, and should not be ventured upon if the patient's welfare is to be considered."⁴⁵ This was very strong language for the time.

Amalgam in the 1880-90s: G.V. Black's Formula

In 1883, Dr. Alton H. Thompson commented before the Kansas State Dental Association, "The presence of amalgam with us is a tremendous fact which we must accept, and accepting, must study. It is a great factor in the dental economy of the day, which cannot be ignored, and we are utterly unable to prohibit its use, even were it as pernicious as some would have us believe ... Amalgam saves more teeth in this country than gold, and is more generally useful."⁴⁶ In 1883, the *Independent Practitioner* reported the death of a Buffalo druggist from swallowing a "large amalgam filling"; however, an autopsy failed to show the filling.⁴⁷ The same year, amalgam fillings were blamed for deafness. Reportedly, the hearing improved after the restorations were replaced with gold.⁴⁸ In the dental profession, the general feel-

ing was that the charges against amalgam "must be proven by its accusers"; "amalgam has the field."⁴⁹ Also, some dentists complained of "partial paralysis" caused by mixing amalgam in the palm of their hand. However, an 1887 article recommended never mixing the alloy in the hand because of the "film of dermal secretions that will be spread over the surface of the mercury." The mix should be made in a "clean rubber or vitrified mortar with a rubber or glass pestle," and compressed on a "piece of washed and dried buckskin."⁵⁰ One dentist said he developed a "dull pain extending from the fingers to the shoulder."⁵¹ Despite the research on amalgam, it was not until 1895 that Dr. Greene V. Black (Figure 5) laid the foundation for a "scientifically balanced alloy." His formula of silver and tin would "neither shrink nor expand in setting" at ordinary room temperature, and did not discolor.²¹ He also found that copper (as much as 5 percent) was beneficial. After Black reported his work in 1895-1896, several dental manufactures sent representatives to his laboratory for instructions in making alloy.⁵²

The Homeopaths: The First Anti-Amalgamists

In 1899, James Youngs Tuthill, MD, of Brooklyn, N.Y., read a paper titled, "Mercurial Necrosis Resulting from Amalgam Fillings," at the Medical Society

of Kings County. He blamed amalgam fillings for mercurial poisoning, which affected the "nerve centers, impairs locomotion by heaviness of limb and stiffness of joint, gives rise to obstinate diseases of the skin, and makes a mental wreck of its victim."⁵³ He cited his own personal experience and five cases he treated, all benefiting from the removal of their amalgam fillings. However, when the paper was discussed, the dentists present, Drs. R. C. Brewster, E.A. Bogue, E.H. Babcock, and A.C. Brush, all challenged his findings. They felt that amalgam made a good restorative material from which "no mercury can be removed so long as it remains in the mouth."⁴⁸ The same year, Richard Grady, MD, DDS, also refuted Tuthill's premise at the meeting of the Maryland State Dental Association. He hoped to "call attention to and record a protest against the views promulgated, in the hope of preventing serious consequences which may follow such teachings."⁵⁴ It seems the homeopathic physicians were the main opponents of amalgam by claiming the absorbed mercury threw the "system out of balance" and caused "derangement of the spleen, stomach, liver, kidneys, nerves, mucous membranes, the skin, etc."⁵⁵ Black reported that at the time of the Civil War, "A little quarrel occurred between dentists in St. Louis regarding the use of amalgam, and very promptly a homeopathic physician took the matter up, and made the contention that the mercury in the amalgam used in filling teeth had a deleterious action upon the system, and that passed into pretty much all the books of the homeopathic creed. Ever since, the homeopaths have objected to the use of amalgam as fillings, notwithstanding the wide observation of dentists that persons with amalgam fillings in their teeth, are just as healthy as any other persons."⁵⁶

Amalgam in the 1900s was recognized as the "great tooth saver" in the hands of the average operator.⁵⁷ In 1908, Dr. E. Bumgardner of Lawrence, Kan., in a paper before the Kansas State Dental Association, stated, "I think that amal-

gam is the best filling material in the world for the place in which it should be put: In a cavity that is properly selected and properly prepared, when the amalgam is properly mixed with a proper alloy, and properly inserted, you have the best filling material in the world."⁵⁸

Amalgam in the 1920s: Professor Alfred Stock

The 1920s began with the report of an incident in the dental literature of an amalgam filling becoming lodged in the lungs and being successfully removed by bronchoscopy.⁵⁹

In 1926, a report came from Germany of Alfred Stock, professor, at the Kaiser Wilhelm Institute of Chemistry, who contracted a chronic case of mercurial poisoning from working in a laboratory for 25 years. The air in the lab "contained

from 0.001 to 0.01 mg of mercury to 1 cubic meter of air." The professor recommended removal of amalgam fillings if "neurasthenic or catarrhal conditions develop for which the physician can find no cause."⁶⁰ In rebuttal, Dr. F. Flury stated that mercury poisoning was not possible with the "complex mixtures" currently used.⁶¹ Finally in 1931, in response to reports of mercury poisoning in primarily foreign medical literature, the National Bureau of Standards in Washington, D.C., conducted tests on amalgam, which concluded that the "claims for mercury poisoning, either as a vapor or as a solution from the standard amalgams passing into the body through the air or food taken into the mouth, are not justified."⁶² The same year the ADA adopted specifications for the purity of mercury, ADA Specification No. 6.⁶³

Amalgam: Mercury Allergy

Reports of true allergy to mercury are scarce in the dental literature; the earliest reports of mercury stomatitis in the 1930s resulting from the use of mercurials in the treatment of syphilis, in which the teeth become "blackened, fragile, blunt and eroded."⁶⁴ Patients were advised to use sodium bicarbonate as a dentifrice on a soft toothbrush.⁶⁵ As the use of heavy metal therapy has been replaced by the antibiotics, references in the literature have been confined to occupational contact with mercury.⁶⁶ However, in 1943, Dr. Bass, a New York pediatrician, reported two cases of "idiosyncrasy" to amalgam fillings in children, and Markow reported a case of mercury allergy in a 41-year-old nurse.^{67,68} The same year, a case of mercurial poisoning was reported in a man who had been prescribed calo-

mel (mercurous chloride) by his physician for “trench mouth” after a severe cold.⁶⁹ In 1951, a case of true allergy to mercury was reported in the *Journal of the American Dental Association*. A 4-year-old girl developed allergic symptoms on two occasions following insertion of amalgam fillings. A patch test was positive for mercury alone, but not amalgam.⁷⁰ Johnson et al. reported the case of a 32-year-old veteran treated at the Dermatological Service, Crile VA Hospital, for sensitivity to his amalgam fillings. A patch test confirmed the diagnosis, and the six teeth with amalgam fillings were extracted.⁷¹ In 1962, the *British Dental Journal* reported a case of mercury allergy in a 33-year-old woman in Stockholm.⁷² In 1963, Engelman reported a case of a 27-year-old woman who had been allergic to mercury since the age of 2.

Two amalgam restorations were placed and the patient developed a “generalized, weeping vesicular eruption, accompanied by an itching sensation,” which was relieved by an antihistaminic. A patch test confirmed the mercury allergy.⁶⁵ In 1969, Frykholm et al. first reported a link between amalgam and lichen planus. A 45-year-old Scandinavian woman had developed the disease on her oral mucosa and tongue. Allergy to the copper in her amalgam fillings was demonstrated by positive skin tests. The replacement of her fillings with copper-free materials resulted in a cure.⁷³ Silver was even blamed for an allergic reaction in a 52-year old female patient.⁷⁴ Wright, in 1971, reported a case of a positive mercury allergy in a 9-year-old girl. She had been sensitized to mercury at the age of 13 months by an ointment applied to her lower lip.⁷⁵ The *British Dental Journal* reported a case in 1982 of a Greek Cypriot who had a positive reaction to amalgam powder when tested. Twenty years earlier, after the insertion of amalgam fillings, he had immediately developed “swollen itching fingers and

lips.” The next day, the fillings were removed and the problem resolved.⁷⁶ In 1983, the ADA reiterated its stance that there was “no reason to remove amalgam restorations from a patient or prohibit the use of dental amalgam in restorative dentistry except in those cases of proved sensitivity of the patient to mercury.”⁷⁷ However, true allergy is rare and may spring from the “unfounded fear that the amalgam may be poisonous.”⁷⁸

Amalgam in the 1960-70s: Mercury Vapor

As early as 1935, McGeorge, in his article on mercurial stomatitis, mentioned that mercury may be inhaled

Giese warned dentists in 1948 that mercury vapor was toxic and that famous scientists, such as Michael Faraday and Blaise Pascal, were victims of “chronic mercury poisoning.”

“in the form of mercury vapor.”⁷⁹ Giese warned dentists in 1948 that mercury vapor was toxic and that famous scientists, such as Michael Faraday and Blaise Pascal, were victims of “chronic mercury poisoning.”⁸⁰ Grossman and Dannenberg in 1949 published their study on mercury vapor in dental offices and laboratories, using a portable General Electric mercury-vapor detector of the instantaneous type. They studied 50 dental offices and concluded that the concentrations of mercury were not toxic to dental personnel; however, they were directly proportional to the “amount of mercury used by the individual dentist.”⁸¹

In 1960, air analyses were conducted in the Helsinki dental school to evaluate the mercury vapor content during the mixing of amalgam. The mercury values were considered below what is a safe margin for dental personnel. The investigators recommended adequate size rooms and proper ventilation.⁸² In 1962, Krykholm and, in 1963, Knapp warned that when the concentration of mercury in the air in the dental office exceeded 1:100,000,000,

it could pose a health hazard to the dental staff.⁸³ Griffith in 1963 reviewed the literature and concluded that the amount of mercury exposure to dental personnel was “not expected to cause any detectable harm at any time during life.”⁸⁴ Joselow et al. in their 1968 study of dental offices showed 14 percent had mercury concentrations in excess of what was considered “good hygienic practice.” Absorption of mercury was evidenced by higher than normal urinary mercury levels.⁸⁵ However, the 1960s ended with the death of a 42-year-old dental assistant with a 20-year history of exposure to mercury in England. She had developed a “rapidly fatal nephritic syndrome,” from mulling amalgam in the palm of her hand.⁸⁶

The concern about mercury vapor extended into the 1970s when squeeze cloths were still being used to express the excess mercury. Then, too, the 1970 Occupational Safety and Health Act created a legal responsibility for the employer-dentist to protect their employees.⁸⁷

In 1970, Gronka and his associates found mercury contamination in one in seven dental offices.⁸⁸ In 1973, Lenihan, Smith, and Harvey surveyed 62 dental practices for mercury hazards. They studied the mercury levels in head and body hair, fingernails and toenails from 183 dentists, dental assistants, and office managers. They concluded that although there was “no evidence that the amount of mercury absorbed is harmful to the patient, there should be “monitoring programmes to assess individual contamination by mercury” for the dental staff.⁸⁹ The American Conference of Governmental Industrial Hygienists recommended a mercury threshold limit of 50 µg/m for a 40-hour workweek.⁹⁰

Finally, in 1973, the ADA House of Delegates adopted a resolution on the biological levels of mercury for the dental team. The guidelines were published in February 1974.⁹¹ Atmospheric mercury is

the primary concern for the dental team. There were many reasons for undetected mercury lying in the dental suite: loose fitting amalgam capsules, accidental spillage, and inhalation of amalgam particles during removal of an old restoration. The ADA recommended personal monitoring of team members rather than area monitoring.⁹² In addition, the council recommended periodic urine analysis by the Hatch and Ott flameless atomic absorption procedure.⁹³ Mercury accumulation in the central nervous system interferes with nerve conduction by "tampering with electric potential across the nerve cell membranes." The symptoms include a psychic aberration known as erthism, which manifests itself as "self-consciousness, embarrassment without justification, disproportionate anxiety, indecision, poor concentration, depression, irrational resentment of criticism, and irritability."

Tremors of the hands can occur along with a brownish-yellow discoloration of the eye lens. Severe cases affect the oral cavity with inflamed and edematous gingival, bleeding gums, and a blue line at the gingival margin. At the terminal stage, the teeth may loosen.⁹⁴ Historically, it was known that hatters in England who used mercury in the felt hat industry developed mental instability and tremors; thus the expression "mad as a hatter."⁹⁵

In 1974, the Department of Health Science, California State University, and the Occupational Health Section, California State Department of Health, reported on an environmental survey of 19 dental offices with 284 dental personnel for mercury vapor. They recommended education on handling mercury for all personnel, proper storage of mercury, proper disposal of waste mercury and amalgam, use of rubber dam for amalgam fillings, suitable amalgam waste traps on cuspidors, proper ventilation in the operatory, wearing oral-nasal dust

masks when removing amalgam fillings, vinyl floor covering in operatories rather than carpeting, scrubbing with soap and water after contact with amalgam products, and periodic urine testing for those handling mercury and amalgam. They concluded that "environmental contamination of dental offices by mercury does not seem to pose an acute health hazard for personnel." However, "dental assistants who handle mercury have the greatest risk of absorption of mercury vapor."⁹⁶ Johnson pointed out that "dentists have a moral and legal responsibility to protect themselves and their employees from high amounts of mercury vapor in the dental office."⁹⁷

Mercury accumulation in the central nervous system interferes with nerve conduction by "tampering with electric potential across the nerve cell membranes."

The U.S. Navy Dental Corps in 1973 investigated the use of a Harold Kruger (Model 24) mercury vapor meter to measure the mercury vapor generated at the evacuation system exhaust, the amalgam preparation cabinet, and the floor of seven operatories at the regional dental center in Norfolk, Va. They recommended a "vigorous program of mercury control, as well as a continuing education program for the hygienic handling of mercury," and a commercial solution known as HgX, or "mercury X," to decontaminate scrap amalgam. In addition, they installed mercury vapor filters (MSA Mersorb cartridges) on the evacuation outlets.⁹⁸ The ADA's House of Delegates in 1975 directed the Council on Dental Materials and Devices to revise the standards for amalgamators, capsules, and proportioners to minimize mercury spillage.⁹⁹ To emphasize the importance of staff education, in 1976, the *British Dental Journal* reported a case of contamination of a dental operatory by a temporary assistant who spilled mer-

cury in the operatory and did not report the accident to her employer.

Subsequently, the regular dental staff all developed symptoms of mercury poisoning. The dentist and his regular assistant experienced severe headaches, nausea, irritability, fatigue, and insomnia. They were treated with N-acetyl-D-penicillamine. Fortunately, there were no fatalities, although there was a prolonged recovery.¹⁰⁰ The same year, a dental office was vandalized and 20 pounds of mercury spilled. Vacuuming the heavily contaminated rugs exacerbated the problem and the carpeting had to be discarded.¹⁰¹

Battistone and his associates at the U.S. Army Institute of Dental Research tested the blood of 1,555 dentists for mercury levels and found the mean for all dentists was 8.2 ng Hg/ml blood (U.S. population 0 to 5 ng Hg/ml). In general, practitioners with high lev-

els tended to "show practice characteristics that were conducive to these higher levels. They concluded that dentists in the United States, as a group, "practice good mercury hygiene."¹⁰² Hefferren, in 1976, recommended hair analyses as a means to measure mercury exposure by the dentist and his staff.¹⁰³

In 1977, the Commission on Dental Materials, Instruments, Equipment and Therapeutics chaired by Dr. J.W. Sanford published its recommendations for handling mercury products. Ten percent of all dental offices in the United States, Canada, and England had air levels of mercury vapor in excess of 0.05 mg/m. Although neither a dentist nor an assistant had suffered from "chronic mercurialism," there was cause for concern.¹⁰⁴ In 1978, the ADA Council on Dental Materials and Devices issued new guidelines for mercury hygiene.

Basically they were the same as the 1974 rules, with the addition of the avoidance of ultrasonic amalgam condensers, use of "water spray and high volume evacuation," and use of a face

mask.¹⁰⁵ However, Roydhouse, professor of restorative dentistry at the University of British Columbia, still felt that “most mercury contamination is needless and a sign of poor occupational hygiene.”¹⁰⁶

Carpeting also came under criticism again in 1981; however, Kantor and Woodcock’s survey of 1,064 rooms in 528 North Carolina dental offices showed “no difference in ambient breathing zone concentrations of mercury vapor between offices with hard floors and offices with carpets.” They recommended that the exposure limit for mercury vapor for dental personnel be reduced from 0.05 mg/cu m to 0.02 mg/cu m.¹⁰⁷ Yamanaka and his associates at the Tokyo Dental College in their 1981 survey of Japanese dental workers showed that dentists had “statistically higher mercury levels in hair and urine” than the control group. Occupational handling of mercury and eating fish was thought to be the causal factor. The dental assistant’s hair mercury was not elevated, but their urinary mercury was higher than the control group. They recommended regular monitoring of hair and urine mercury.¹⁰⁸

Another method recommended was the use of commercial monitors. Basically, there were two types: the palladium chloride film detector and the gold film detector.¹⁰⁹

Despite the popularity of composites, it was estimated that 85 percent of posterior restorations inserted in the United States in 1984 were amalgams. Langan et al. found “no evidence in the scientific literature that the minute amounts of mercury vapor that may be released from amalgam restoration can cause mercury poisoning.” However, they admitted the association between amalgam restorations and oral lichen planus “requires further investigation.”¹¹⁰ In 1984, the ADA Council on Dental Materials, Instruments, and Equipment issued new guidelines for mercury hygiene, which were much more

detailed than the earlier recommendations. They recommended a well-ventilated operating room; monitoring for mercury vapor once a year or after a mercury spill; following the National Institute for Occupational Safety and Health’s threshold limit for mercury of 50 µg/m, based on an eight-hour workday; periodic urinalyses for all dental staff; using single-use, precapsulated alloy; using water spray and high-volume evacuation when removing old amalgam; wearing a face mask to avoid breathing amalgam dust; storing amalgam scrap covered by a sulfide solu-

The ADA estimated that each year, more than 100 million amalgam fillings were inserted in the United States, and that fewer than 50 cases of allergic reactions to mercury had been reported since 1905.

tion in tightly closed containers; avoiding direct handling of mercury or amalgam; and checking clothing for mercury before leaving the office.¹¹¹ In 1985, the ADA reported that the urinary mercury levels for 4,272 dentists who participated in their health assessment program (1975-1983) had a mean level of 14.2 µgm/l.¹¹²

U.S. Air Force investigators even found that amalgam-contaminated instruments placed in a chemical vapor sterilizer contaminated the sterilizer. Paper sterilization bags were effective in containing mercury vapor and reduced it to zero, but once a sterilizer became contaminated; it could not be effectively decontaminated. Still, from 1989 to November 1990, eight episodes of mercury exposure in private homes or schools were reported to the Agency for Toxic Substances and Disease Registry. In one case, an individual was smelting dental amalgam in a casting furnace in his basement to recover the silver from the amalgam. Apparently, mercury fumes had entered the air ducts and circulated throughout the house.¹¹³ Agocs studied the effects of paint com-

panies using phenylmercuric acetate as a preservative to prolong the shelf life of interior latex paint. She tested 74 exposed people in recently painted homes and 28 control people in homes not painted, and found that “potentially hazardous exposure to mercury” had occurred among those in the painted homes at approximately 2½ times the Environmental Protection Agency’s recommended limits.¹¹⁴

The Anti-Amalgamists: 1980-90s

The anti-amalgamists became active again in the 1980s, despite the lack of evidence. The National Institute of Dental Research issued a statement in 1984 that “health hazards of blood mercury levels associated with dental amalgams have not been documented ... and there

appears to be little correlation between (mercury) levels in urine, blood or hair, and toxic effects.” The same year, the U.S. Public Health service stated that patients “should not seek replacement of amalgam fillings ... based on a fear of harm.” The ADA estimated that each year, more than 100 million amalgam fillings were inserted in the United States, and that fewer than 50 cases of allergic reactions to mercury had been reported since 1905. The National Multiple Sclerosis Society issued a strongly worded statement that amalgam had no cause or effect on the disease. Groups carrying the torch against amalgam were identified as Dental Amalgam Mercury Syndrome, and the Foundation for Toxic Free Dentistry.¹¹⁵

However, the main protagonist against amalgam seems to have been Dr. Hal A. Huggins, a Colorado dentist. In 1982, he published a paper, “Mercury: A Factor in Mental Disease.” He blamed the “mercury leaching out” of dental amalgam fillings for affecting the “peripheral nervous system, immune system, and cardiovascular system.”¹¹⁶ All these charges were made

without scientific proof. Alexander A. Fisher, MD, in response to these charges, reiterated that dental amalgam presented “no known general health threats” to patients.¹¹⁷

In 1984, Miller and his associates at Baylor College of Dentistry conducted patch tests on 171 dental students for mercury sensitivity as they passed through the dental curriculum. They found “no significant increase in development of allergic reactions” although there apparently was a correlation between the number of alloy restorations and the incidence of positive reactions. Their conclusion was that mercury was not a “significant allergen for practicing dentists and their assistants.”¹¹⁸ Their results differed from the earlier (1976) study of White and Brandt, who concluded there was an increase in student hypersensitivity.¹¹⁹ A 1985 survey of dentists and dental assistants (21,634 dentists and 21,202 assistants) for birth defects, conducted at Stanford University School of Medicine, found that the levels of mercury exposure commonly present in the dental environment apparently “do not influence the rate of spontaneous abortions or the number of children born with congenital abnormalities.”

General dental practitioners as a group do have “blood mercury levels higher than those of the general population.”¹²⁰ However, a Swedish 1986 necropsy study found large amounts of mercury in the pituitary glands of dentists. They concluded that patients with amalgam fillings may have increased levels of mercury in their pituitary glands and that “dentists should handle amalgam carefully.”¹²¹ However, in 1986, the ADA reaffirmed its position that amalgam did not “pose a health hazard to the nonallergic patient,” and said that its removal from nonallergic patients for the “alleged purpose of removing toxic substances from the body, when such treatment is performed solely at the recommendation or suggestion of the dentist, is improper and unethical.”¹²²

The Debate Continues: 1990-2002

Haikel and his group at the Pasteur University in their study of the patient’s exposure to mercury vapors in 1990 found that mercury vapor was released

“during insertion, condensation, carving, and removal of amalgam.” The mercury was measured in the intraoral air using atomic absorption spectrometry.¹²³ The same year, Clarkson reported

that acrodynia or mercury poisoning in young children was not caused by chewing on amalgam fillings.¹²⁴ One British wit even brought up the subject of the effect which “cremation of deceased people with amalgam restorations has on the ambient atmosphere near a crematorium.”¹²⁵

The “mercury scare” was highlighted by television network CBS in their 1990 *60 Minutes* show, which presented a “gaggle of less-than-credible patients ... to testify to their miraculous recovery from a variety of specific or amorphous maladies.” By contrast, the message *Consumer Reports* had conveyed to its readers back in 1986 was that “if a dentist wants to remove your fillings because they contain mercury, watch your wallet.”¹²⁶ In 1991, the FDA dental devices panel concluded that “none of the data presented show a direct hazard

to humans from dental amalgams.”¹²⁷ The same year, Dr. L. Jackson Brown, acting director of Epidemiology and Disease Prevention Program, National Institute of Dental Research, National Institute of Health, Bethesda, Md., called the amalgam question “an issue serious enough to merit additional research.”¹²⁸ Moreover, in 1991, Mortensen brought up the question of the safety of the composite restorations that are replacing amalgam. Do composite materials remain “unchanged in the hostile oral environment of physical and chemical attacks”; and are the dental professionals who inhale the “solvent-laden vapors” on a daily basis safe? Has our experience with composites been long enough to “presume safety?”¹²⁹ Eley and Cox also brought up the “long-term biocompatibility” of composites and their shorter clinical life, adding to both the cost and “progressive tooth destruction.”¹³⁰

In 1996, at a symposium held by the International Association for Dental Research (Continental European and Scandinavian Divisions) in Berlin, Germany, Ekstrand et al. concluded

that “exposure to amalgam fillings does not cause serious health risks to large numbers of individuals in the general population and, consequently, removal of intact amalgam fillings is not indicated.” Despite this statement, the Swedish government in 1995 banned the use of amalgam in all public health clinics for children, and recommended that it not be used in adults after 1997.¹³¹ The same year, Sandborgh-Englund et al. in Sweden investigated kidney function in 10 subjects after exposure to mercury during dental treatment and found “no signs of renal toxicity in conjunction to and after mercury exposure from the removal of amalgam fillings.”¹³²

As a sign of the times, in 1999, some 86 million composite restorations were placed in the United States as contrasted to 71 million amalgam restorations.

On May 13, 1997, the NBC network aired a segment on *Dateline*, which provided a “very accurate and well-balanced review of the dental amalgam issue.”¹³³ The same year, Eley reviewed the dental literature and noted that a pacifying layer of corrosive products is formed on amalgam fillings, which is disturbed by tooth brushing and chewing. The mercury released is in the form of vapor, which passes into the intraoral air or as mercury ions, which passes into the saliva and gastrointestinal tract (between 1 to 2 µg per day).¹³⁴ The ADA Council on Scientific Affairs adopted new recommendations for mercury hygiene in October 1998 to update the 1991 guidelines published by the former ADA Council on Dental Materials, Instruments and Equipment. Basically they were the same as the previous ones, but recommended recycling scrap amalgam according to state and federal laws, disposing of mercury-contaminated items in sealed bags, and removing professional clothing before leaving the workplace.¹³⁵ As far as scrap

amalgam as a source of pollution in the United States, in 1992, batteries “accounted for 86 percent of discarded mercury and dental amalgam a mere 0.56 percent.”¹³⁶

As a sign of the times, in 1999, some 86 million composite restorations were placed in the United States as contrasted to 71 million amalgam restorations. The reasons were the improvements in composite materials and techniques, and the public demand for more esthetic, tooth-colored restorations.¹³⁷ In 2002, the Food and Drug Administration proposed to upgrade dental mercury from a Class I (low risk to patients) to a Class II medical device, which would require amalgam

manufactures to list the special controls and regulations of manufacture of the product ingredients on their labels.¹³⁸

Gottwald and associates, in their 2002 publi-

cation *Psychotherapy and Psychosomatics* found “no significant correlation between psychic distress and mercury burden.” They concluded that “the theory that amalgam-related complaints are often an expression of underlying psychic problems seems to be more reasonable than the theory of mercury intoxication or the theory of an amalgam allergy.”¹³⁹

In December 2003, Dr. Frederick Eichmiller, director of the ADA Foundation’s Paffenbarger Research Center, testified, “The overriding body of scientifically valid and peer-reviewed research supports only one conclusion: that amalgam is a safe, affordable, and durable material.” He added that the major U.S. and international scientific and health organizations, including the national Institutes of Health, U.S. Public Health Service, Food and Drug Administration, Centers for Disease Control and Prevention and World Health Organization have all stated that “dental amalgam is a safe restorative material.”¹⁴⁰

Anti-Amalgam Bills: 2003

As a sign of the times by 2003, anti-amalgam groups had persuaded lawmakers in nine states (Arizona, Arkansas, California, Georgia, Illinois, Maine, Massachusetts, Oregon, and Washington) to introduce legislation to "restrict or eliminate the use of amalgam in dental restorations." Cathy Mudge of the California Dental Association stated, "Opponents of dental amalgam have not been successful in raising concerns about the safety of amalgam as a restorative material, so they appear to have changed their strategy and are attempting legislation that will make it more difficult for dentists to continue using amalgam. ... All this at the expense of so many patients who benefit from the durability, longevity and safety of dental amalgam."¹⁴¹

Rick Murray of the Arizona Dental Association emphasized the fact that the anti-amalgamists were "very clever in their tactic to blur the line between amalgam and mercury," using "amalgam as a synonym for mercury." As a consequence the lawmakers believe that "amalgam and mercury are one and the same."¹⁴²

On Feb. 18, 2003, the New York Supreme Court dismissed two amalgam-related lawsuits against organized dentistry, stating the plaintiffs had "failed to show a 'cognizable cause of action.'" Originally, the suit had been filed in Syracuse, N.Y., by Shawn Khorrami, a Los Angeles attorney. The plaintiffs blamed the ADA, the New York Dental Association, and the Fifth District Dental Society for deceiving the "public about health risks allegedly associated with dental amalgam." Khorrami also filed similar suits in California and Maryland.¹⁴³

Conclusion

Amalgam has served the dental profession for more than 150 years. Incidents of true allergy to mercury have been rare (only 41 cases have been reported since 1905), and attempts to

link its usage with such diseases as multiple sclerosis and Alzheimer's have not been scientifically proven, although there may be some association between amalgam restorations and oral lichenoid lesions.^{144,117} As recently as May 2005, the ADA endorsed amalgam as being safe for pregnant women.¹⁴⁵ Still, the anti-amalgamists persist in their efforts to discredit the dental profession and the ADA for supporting amalgam as an economical, long-lasting, tooth-saving, and effective restorative material. On the positive side, perhaps because of their efforts, more emphasis has been placed on mercury hygiene in the dental office. Where the story of amalgam will end remains for the future. **CDA**

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The Effect of Xylitol on *Streptococcus Mutans* in Children

Dominique Massoth; Gabrielle Massoth; I. Richard Massoth, DDS, MSD;
Lise Laflamme, DMD; Wenyuan Shi, PhD; Chuhong Hu, and Fang Gu, DDS, PhD

ABSTRACT

A study was performed on 91 second-grade students from the Los Angeles Unified School District to test the effects of xylitol chewing gum on *Streptococcus mutans* in the saliva. Saliva was collected from students and tested for the first time using the new University of California, Los Angeles, monoclonal antibody testing method. Students found to have moderate or high levels of salivary *S. mutans* were administered four tablets/day of xylitol gum for three weeks. The levels of *S. mutans* in the saliva of children in the high caries index subgroup decreased by 61.7 percent. Xylitol can be dispensed in a public school setting by school nurses and can be a very safe, efficient and inexpensive preventative measure for children at high risk for dental caries.

Streptococcus mutans was first isolated by J.K. Clark in 1924 and has long been considered as the primary etiologic agent in the development of dental caries.¹⁻⁵

Many other studies have verified the correlation between the proportion of *S. mutans* in saliva and the incidence of tooth decay.⁶⁻⁹ W. Shi and his group at the University of California, Los Angeles, first described a rapid and quantitative detection of *S. mutans* in 1998.⁶ This method used fluorescence labeled monoclonal antibodies specific against *S. mutans*, thus avoiding the pitfalls of earlier studies using inherently inaccurate culture assay detection methods.¹⁰⁻¹² This method was further refined and developed into a simple and inexpensive saliva test distributed by the Department of Oral Biology at the



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Disclosure / Dominique and Gabrielle Massoth received a grant from the California Dental Association Foundation for this work.



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UCLA School of Dentistry. This simple test made it possible to assess the beneficial effect of xylitol in reducing caries risks in schoolchildren in a convenient and cost-effective manner.

Xylitol is a naturally occurring five-carbon sugar alcohol commercially made from xylan hemicelluloses, which include corn cobs and hardwood trees. Clinical studies have shown it to be both noncariogenic and cariostatic.¹³⁻¹⁶ Hays reviewed 14 clinical studies from 1966 to 2001 and found a consistent decrease in dental caries ranging from 30 percent to 60 percent among subjects using sugar substitutes as compared to subjects in a control group.¹⁶ Since xylitol is virtually nonfermentable by dental plaque, consumption of xylitol can result in a decreased production of lactic acid and glucans that make the plaque sticky. It may also enhance ammonia formation in plaque, which may neutralize the lactic acid.

Based on these clinical findings, the authors hypothesized that upon identification of children with high levels of *S. mutans*, the administration of xylitol four or five times a day may likely lower the levels of *S. mutans*. Additionally, data was to be collected for the first time using the UCLA antibody assay method. Finally, the efficacy of administration by school nurses and parental compliance would be tested.

Materials and Methods

Patients' recruitment. One-hundred fifty-eight second-grade students from Sunny Brae Elementary School in Canoga Park, Calif., were eligible to be tested. A flier was printed in English and Spanish languages so the parents of each student would be fully educated about the experiment. Ninety-six parents gave consent for an equal number of children to participate in the study.

The children were categorized in one of three caries index levels. Seventeen children with less than 10,000 *S. mutans*/ml of saliva were placed in the low-caries-risk subgroup; 51 children with 10,000 to 150,000 *S. mutans*/ml of saliva were categorized into the moderate-caries index subgroup; and 23 children above 150,000 *S. mutans*/ml of saliva became the high-caries-risk subgroup. These categories were quite similar to those used

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in the UCLA study of salivary *S. mutans* levels counted by the monoclonal antibody testing method of more than 5,000 children.⁷ The parents of the 17 children in the low-caries-risk group were notified that they did not need to participate further in the study.

Saliva collection and testing. A pipette was used to collect 0.45 mL of the saliva and to transfer it to a 1.5 mL Eppendorf test tube containing 0.05 mL of formaldehyde. Students did not consume food within two hours of saliva collection and these samples were collected around 11 a.m. Ninety-one samples were sent to the UCLA oral microbiology laboratory for processing within 24 hours. The UCLA lab used the monoclonal antibody-based detection method with fluorescence microscopy to

determine the numbers of *S. mutans* cells per mL of saliva.

The experimental design and testing scheme. A large supply of xylitol chewing gum was purchased at Epic Dental in Provo, Utah. Each piece of gum weighed 1.08 grams and was 67 percent xylitol. The 74 parents of the children in the moderate- and high-caries-risk subgroups were sent a bilingual notice detailing the instructions for the experiment. Each of these parents also received a 21-day supply of xylitol chewing gum and a compliance checklist. Every time the parents dispensed the xylitol chewing gum to their child, the child was expected to chew it for five minutes. The parents then checked off the appropriate box on the checklist. After 21 days, the checklists were collected and examined for compliance. Students who did not bring in their checklist were omitted from the compliance mean calculation. Sixty-nine children were retested at 2:30 p.m. after the 21st day of chewing xylitol gum.

Human subjects consent. This project was approved in its entirety by Steven M. Cantrell, PhD, chief research scientist at the Los Angeles Unified School District. Each participating child returned a signed, written informed consent from their parents. All instructions and consents were printed in English and Spanish.

Results

Twenty-two of the 23 high-caries-risk children showed decreases in their salivary levels of *S. mutans* after chewing xylitol gum for 21 days. The statistical analysis to compare *S. mutans* counts before and after xylitol chewing was performed using statistical software STATA version 9. For the high-risk group, after log transforma-

tion, the data was checked by a normality test to make sure it followed the normal distribution. A paired t test procedure was then applied. The result showed the decrease in the salivary *S. mutans* counts in the high-risk group after the application of xylitol was statistically significant ($P < 0.0001$). The mean decrease (Table 1) for the 23 high-carries-risk students was 16,491 cells/ml of saliva or 61.7 percent. The 46 children tested in the moderate-carries index subgroup showed a 44.2 percent or a 29,630 cells/ml increase (Table 1) in salivary *S. mutans* after the xylitol chewing. This result was not statistically significant ($P < 0.0001$).

The compliance rates were calculated by having each parent count and report the number of tablets left after 21 days. These results were verified by collecting the compliance sheets. Only 76.8 percent of the students returned their compliance sheets. The compliance rates ranged from a low of 19 percent to a high of 100 percent. This was calculated for each student by dividing the gum tablets chewed by the 84 tablets dispensed. The mean compliance rate for the 76.8 percent that returned their checklists was 90.7 percent. Therefore, the average number of tablets chewed was 76 out of the possible 84 dispensed for those that returned the compliance sheets.

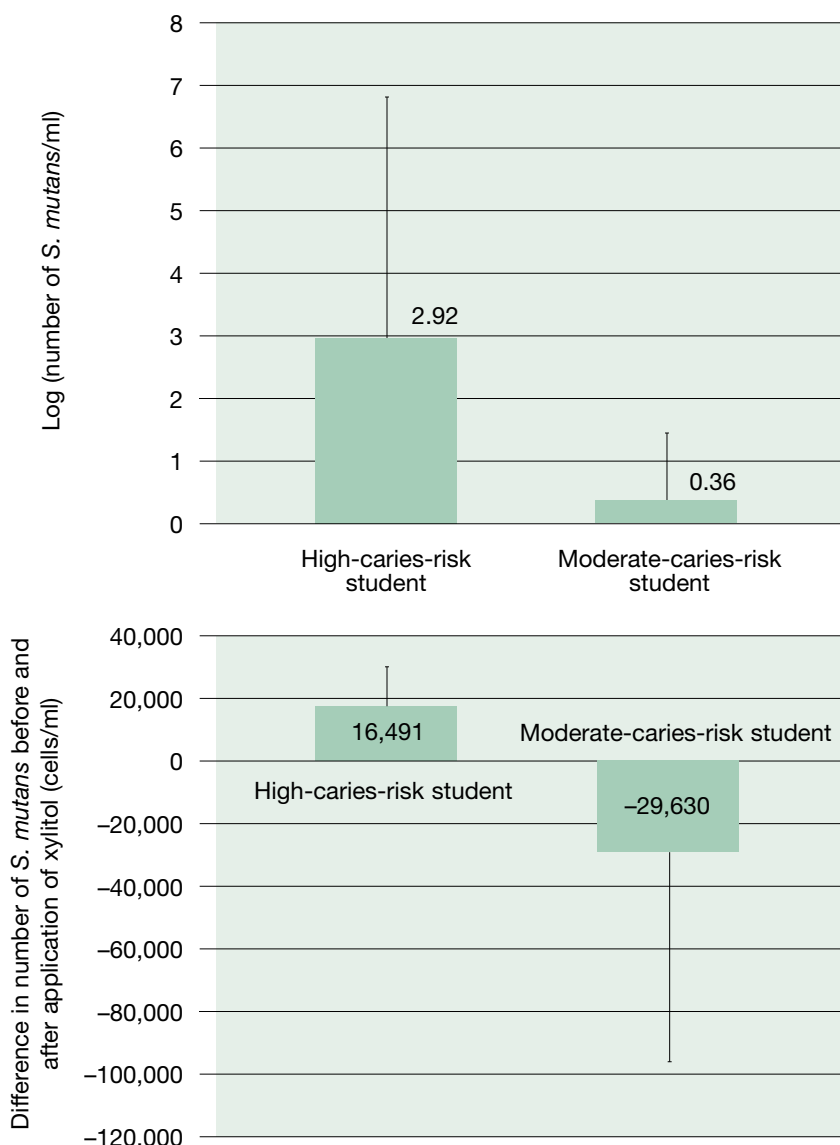
Discussion

Since 95.6 percent of the children in the high-carries index subgroup showed decreases in their levels of *S. mutans* after xylitol chewing, it seems that this gum was quite helpful to those at high-carries risk. In fact, the 61.7 percent reduction in *S. mutans* indicates xylitol may inhibit *S. mutans* much more than expected.

The xylitol was far less impressive

Table 1

The graph was plotted based on the mean of the differences of *S. mutans* counts in each subject between before and after the application of xylitol for 21 days. There were 23 students in high-carries risk group and 46 students in moderate-carries risk group. The error bar showed the standard deviation (SD) of the differences in *S. mutans* counts. Statistical analysis was performed with statistical software STATA (version 9). The data of *S. mutans* counts was log transformed to fulfill the normality requirement before the application of a paired t test to examine whether there was any statistically significant difference in the salivary *S. mutans* counts before and after the application of xylitol. The results showed a significant decrease in the salivary *S. mutans* counts in the high-risk group before and after the application of xylitol ($P < 0.0001$).





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in reducing *S. mutans* in the moderate-carries index subgroup. In fact, this subgroup showed a 44.2 percent increase in salivary *S. mutans* that was not statistically significant. The result from one student in this subgroup was eliminated since his saliva was contaminated. It was found that there was great variability in salivary *S. mutans* counts when they were collected at different times during the day. School scheduling constraints permitted initial sampling at 11 a.m. and testing after xylitol administration at 2:30 p.m. This may explain the extreme variability and high error bar (Table 1) in the counts from the moderate-carries index subgroup.

The average compliance rate was 90.7 percent of the dispensed tablets over the 21 days for the 76.8 percent of the children who returned their compliance sheets. Since almost one-quarter of the parents did not return the compliance sheets, it appears that initial communications and instructions need to be improved to establish a more effective program for testing in a public school setting.

Some of the limitations of this study were the lack of a control group and the possibilities of sampling errors. It was extremely difficult to get approval for this project from the chief research scientist of the Los Angeles school district. Approval was not granted to use any students for a control group. Previous studies have shown that regular chewing gum has a very limited effect on *S. mutans*, which would serve as a negative control in this case.¹⁴ Nevertheless, the reductions of *S. mutans* were dramatic in the high-carries risk group and this mirrors the results found in the UCLA study with more than 5,000 children.⁷ Contamination could have occurred in

collecting the saliva into the cups and then transferring it to the test tubes as the nurses were inexperienced in carrying out this procedure. However, the improved accuracy of monoclonal antibody testing over the previous standard of selective culture assay methods is well documented.^{6,7}

One of the main goals of this study was to see if the school nurses could organize the logistics and various stages of the school testing. Once they had received the proper training, they were quite capable of running the program independently. Well-controlled double-blind clinical trials are still needed with more attention to parental compliance. The UCLA antibody assay method was first used and found to yield a more accurate count of *S. mutans* in the saliva than previous, nonspecific culture assay methods.^{6,7} It appears that xylitol can be a very safe, efficient and inexpensive protective measure for children at high risk for dental caries.

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CALIFORNIA COMMUNITY RESIDENTIAL FACILITIES FOR INDIVIDUALS WITH INTELLECTUAL AND DEVELOPMENTAL DISABILITIES

H. Barry Waldman, DDS, MPH, PhD, and Steven P. Perlman, DDS, MScD

Abstract

Evolving residential requirements for individuals with mild and moderate intellectual disabilities and related developmental disabilities increasingly place these people in community settings. The increasing numbers of these individuals are dependent upon local practitioners for needed health services. National and California data are reviewed in an effort to provide a general awareness of these community living arrangements, which in turn may assist in the delivery and the follow-up of oral health services.

In 2003, there were an estimated 145,580 residential settings in the United States in which those with intellectual disabilities and related developmental disabilities, ID/DD, received services. These settings exclude psychiatric facilities, nursing homes and private homes in which people received services while living with family members. In 2003, approximately 35,000 people with ID/DD were residents of nursing homes. These facilities were state-operated or state-licensed residential service providers. In the past 25 years, the number of these residential settings has grown more than 11-fold.¹

The dramatic increase in the number of smaller residential settings for care (99 percent had 15 or fewer residents, 94 percent had six or fewer residents, and more than 95 percent of nonstate-operated settings had six or fewer residents) is a consequence of the deinstitutionalization of individuals with ID/DD. In 1967, there were more than a quarter of a million U.S. individuals with ID/DD in large state institutions. Changing social policies, favorable legislation for individuals with disabilities, and class-action legal decisions, which delineated the rights of individuals with ID/DD, have led to deinstitutionalization (i.e.

"mainstreaming," establishment of community-oriented group residences and enhanced personal family residential settings) and closure of many state-run large facilities. For example:

■ In 1977, there were about 54,100 child and youth residents with ID in these large state facilities. By 2000, the number of these young residents in the remaining 189 large facilities had decreased to 2,100 individuals.

■ The total number of individuals of all ages in these locations had decreased from 151,100 (in the mid-1970s) to 47,300 by the beginning of the new century.^{2,3}

■ By 2003, nationally, almost one-third of a million individuals with ID/DD, including 44,500 California residents, lived in facilities with fewer than 16 residents (Table 1).



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**Table 1**

Number of California and U.S. residents (in thousands) with intellectual disabilities and related developmental disabilities living in small and large residential facilities: 1977, 1991, 2003¹

Year	California				United States			
	Number of residents < 16 (in 000s)	16+ (in 000s)	Total	Rate per 100,000 pop.	Number of residents <16 (in 000s)	16+ (in 000s)	Total	Rate per 100,000 pop.
1977	8.9	17.3	26.1	120	40.4	207.4	247.8	115
1991	20.1	12.3	32.5	107	161.9	125.3	287.2	114
2003	44.5	6.4	50.9	153	329.8*	72.5*	402.3	143

* Estimated

In the past, the residents with ID/DD in the state institutions received needed dental and medical services from health practitioners in the clinical facilities of these large residential institutions. But, most of the community residential facilities are too small in size to provide needed dental services. As a consequence, individuals with ID/DD who reside in our communities are dependent upon local practitioners for needed oral health services. There is the added reality that many of these individuals with special needs, who now reside in our communities, are members of families that already are patients of record of most local dental practitioners. See a previous presentation in the *Journal of the California Dental Association* for an extended review of the geographic distribution of the almost 300,000 children with disabilities in the state.⁴

When community dental practitioners are called upon to provide the needed care for individuals with ID/DD, as with the care of most patients, a general awareness of living arrangements may assist in the delivery and the follow-up of oral health services.

Table 2

U.S. residential facilities for individuals with intellectual disabilities by employment size of enterprise: 2001⁵

Number of employees per firm	Firms	Establishments	Total number of employees (in 000s)	Avg. salary per employee (in 000s)
<20	1,839	1,883	12.4	\$16.4
20-99	1,093	2,353	48.7	\$17.4
100+	1,219	12,279	232.2	\$18.9
Total	4,151	16,515	293.3	\$18.6

Firms, Establishments and Residences

In 2001, the Census Bureau reported that for nonstate enterprises with employees, there were more than 293,000 individuals employed by 4,151 commercial firms that maintained 16,515 establishments for residents with ID/DD. An establishment is a single physical location where services are performed. It is not necessarily identical to a firm, company or enterprise, which may consist of one or more establishments. The average annual salary for an employee, including full- and part-time employees, was \$18,600, with employ-

ees of smaller firms averaging \$16,400 (Table 2). For the most part, residency personnel tend to receive wages at the lower end of the salary scale.¹

■ Only Mississippi reported that a majority of individuals with ID/DD who were receiving residential services lived in larger facilities, 16-plus residents.

■ There has been a slow increase in the number of people with ID/DD, 42,300 in 2002, living in host family/foster care settings.

■ About 22 percent of people receiving ID/DD residential services live in their "own home" that they own or lease.

■ Almost an estimated 500,000 individuals with ID/DD reside in their family homes.

Residents

National

Large facilities with ID/DD populations are overwhelmingly made up of non-elderly adults and increasingly, middle-aged adults. In 2002, 86 percent of residents in large institutions were between the ages of 22 and 62.

■ Every state, except Alaska and Vermont, operated at least one large state ID/DD facility.

■ The average annual per person cost in a large facility was \$131,000 in 2003.

■ Males remain a substantial majority among residents in large facilities, 63 percent in 2002.

■ Individuals with the most severe and profound cognitive impairment represent an increasing proportion of the residents in large state facilities, almost two-thirds of all residents in 2002. Those with mild or moderate intellectual disabilities increasingly reside in local community facilities.

■ In mid-2002, based on reports from 36 states, an estimated 60,000 individuals with ID/DD were awaiting residential services.¹

California

In line with the national transfer of individuals with ID/DD to smaller facilities, more than 87 percent of California residents with ID/DD receiving residential services live in locations with fewer than 16 individuals. Corresponding with national data, residents of these smaller community facilities primarily are people with mild or moderate intellectual disabilities.

Table 3

California and U.S. individuals with intellectual disabilities and related developmental disabilities residing in state and nonstate run institutions: 2002¹

Residential setting	California Number of residents				United States	
	1-3	4-6	7-15	16+	Total	Total
Nonstate-run		42,053*	1,775	3,007	46,835	336,113
State-run	0	0	0	3,671	3,671	56,627

* Includes both 1-3 and 4-6 residents.

Table 4

Per diem expenditures for California and U.S. individuals with intellectual disabilities and related developmental disabilities residing in state institutions: 1977, 1991, 2003¹

Year	California	United States
1977	\$55	\$44
1991	219	206
2003	489	359

Table 5

California and U.S. youngsters (newborn to 21 years) with intellectual disabilities and related developmental disabilities as a proportion of total population with ID/DD living in residential facilities: 1977, 1991, 2002¹

Year	California	United States
1977	39 percent	36 percent
1991	13	9
2002	6	5

■ In most years since the mid-1970s, California has had a higher ratio of individuals with ID/DD living in residency facilities (153 people per 100,000 state residents in 2003) than the national average (143 individuals per 100,000 of the general population). The highest rate,

in 2002, was reported by North Dakota (319 people per 100,000 state residents); the lowest by Arizona (56 persons per 100,000 state residents) (Table 1).¹

■ All of the individuals with ID in smaller residential facilities live in non-state-run residences (Table 3).



■ Per diem expenditures for California individuals with ID/DD residing in state institutions reached \$489 in 2003. Since the mid-1970s, California per diem expenditures consistently have been higher than the national average (Table 4).

■ In the mid-1970s, youngsters through age 21 represented 39 percent of all California residents with ID/DD residing in large state institutions. By 2002, youngsters who represented 6 percent of residents with ID/DD lived in these institutions (Table 5).

Significance of Change

Smaller state-operated and state-licensed voluntary and commercial enterprises, family residencies, and just about any combination of community locations now provide the primary setting for the increasing number of individuals with ID/DD who live in our neighborhoods. The perception that somehow these individuals with special health care needs are cared for in some "out of the way" location by government employees no longer rings true.

The facts are:

■ Almost one-third of a million individuals with ID/DD, more than 44,000 in California, live in small residential facilities.

■ In line with the national transfer of individuals with ID/DD to smaller facilities, more than 87 percent of California residents with ID/DD receiving residential services live in locations with fewer than 16 inhabitants.

In many ways, community group homes have become variations of family arrangements for individuals with mild or moderate intellectual disabilities.

The added reality is that these individuals are long-term residents of our communities who require a wide range of services: from employment to recreation, as well as needed social and health services. An increased awareness of the changed residential setting in our communities for individuals with intellectual disabilities and related developmental disabilities can only improve the potential for the delivery of needed care. **CDA**

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The Devil in Dolores' Dentition



The phenomenon
of demonic
possession probably
goes back to the
beginning of history.

ase history: Hornbostel, Dolores, white, female, DOB 9-26-1948. Presented 2-4-1958 with generalized nonspecific complaint of toothache in ALL her mixed dentition. Dolores was diagnosed as having traumatic episodic disorder (TED) resulting from an encounter with Punxsutawney Phil, the famous groundhog whose observation of his shadow each Feb. 2 determines for the entire Northern Hemisphere whether there will be six more weeks of winter or not. In 1958, Phil did see his shadow, but in a fit of pique, refused to return to his burrow, citing early-onset claustrophobia as his prima facie excuse. In the

resulting confusion, Dolores' mother, Harriet, was nipped on the heel, and winter lasted until July 9 in Pennsylvania that year.

Subsequently, Dolores has been visited by a host of ailments ranging from post-traumatic hallucinatory visions of rabid rodents running rampant to musical interludes seemingly emanating from her amalgam fillings. She has been treated unsuccessfully over the years by a series of dentists, neurosurgeons, chiropractors, holistic tarot card readers, and clinical psychologists. The consensus: Dolores is a victim of demonic possession.

The phenomenon of demonic possession

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The demonic music ceased and has not returned,
nor the patients awaiting treatment in his reception room.

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probably goes back to the beginning of history. Columbus, it is said, was possessed by a particular demon who badgered him with the notion that India, a land of incalculable riches, was but a few kilometers due west off the coast of Portugal. Scurvy, the demon assured him, was only a personal hygiene problem, not a medical one, then laughed devilishly, knowing that ascorbic acid deficiency was not a covered benefit under his Flat Earth Indemnity HMO policy.

It wasn't until Linda Blair in the film *The Exorcist* made pea soup a slow mover in grocery stores for nearly two years, that the public became obsessed with demonic possession. Further interest in the subject was heightened by comedian Flip Wilson, whose frequent infractions were explained by him as "the devil made me do it!"

The good news for dentists, whose appointment books are sprinkled with patients of questionable lucidity and their undiagnosable symptoms, is that exorcisms are on the rise. Scott Lilienfeld, a professor of psychology at Emory University in Atlanta cites the 84-page Roman Ritual instruction manual produced by the Vatican in 1999 on how to conduct an exorcism. Heretofore, when a dentist encountered a patient whose complaints were beyond any diagnosis of known dental problems, he promptly referred him to a series of specialists until the patient returned full circle to his practice with the complaint unresolved.

In an exorcism, a priest performs a ceremony that includes sprinkling holy water onto the possessed and reciting prayers ordering the devil to depart. Unfortunately, the 1999 Exorcism

Manual is not specific for dental demonic problems.

As we tread carefully into this new area of treatment modality, certain hypotheses may be necessary. For example, Sherman Wormsley, DDS of Arbutnot, Texas, having successfully rid a patient of an alleged demon who played continual hip-hop tunes from a newly cemented three-unit PFM bridge, had this suggestion: "We found eugenol sprinkled on the patient was more effective than holy water, but best of all was when we had some Buckley's formocresol blessed, and doused it liberally over the patient and nearby equipment in accordance with OSHA recommendations."

Not having any Vatican-approved prayers for his particular needs, Wormsley said he and his staff chanted excerpts from the PDR in the original English. The demonic music ceased and has not returned, nor the patients awaiting treatment in his reception room.

Dr. Wormsley feels the results of his procedure were so salutary, he is considering its possible benefits to certain concerts where "music" of this genre is *de rigueur*.

In the meanwhile, CE courses must be set up for this new modality. Pending implementation, dentists are advised to have several religious persons representing all denominations in attendance. A qualified psychiatrist certified in demonics should be on hand to oversee any problems should the demon, like Punxsutawney Phil, refuse to return to his lair.

Pharmaceutical note: The effects of formocresol are said to wear off the demon in six months, but will linger in your operatory for eternity. CDA