OF THE CALIFORNIA DENTAL ASSOCIATION

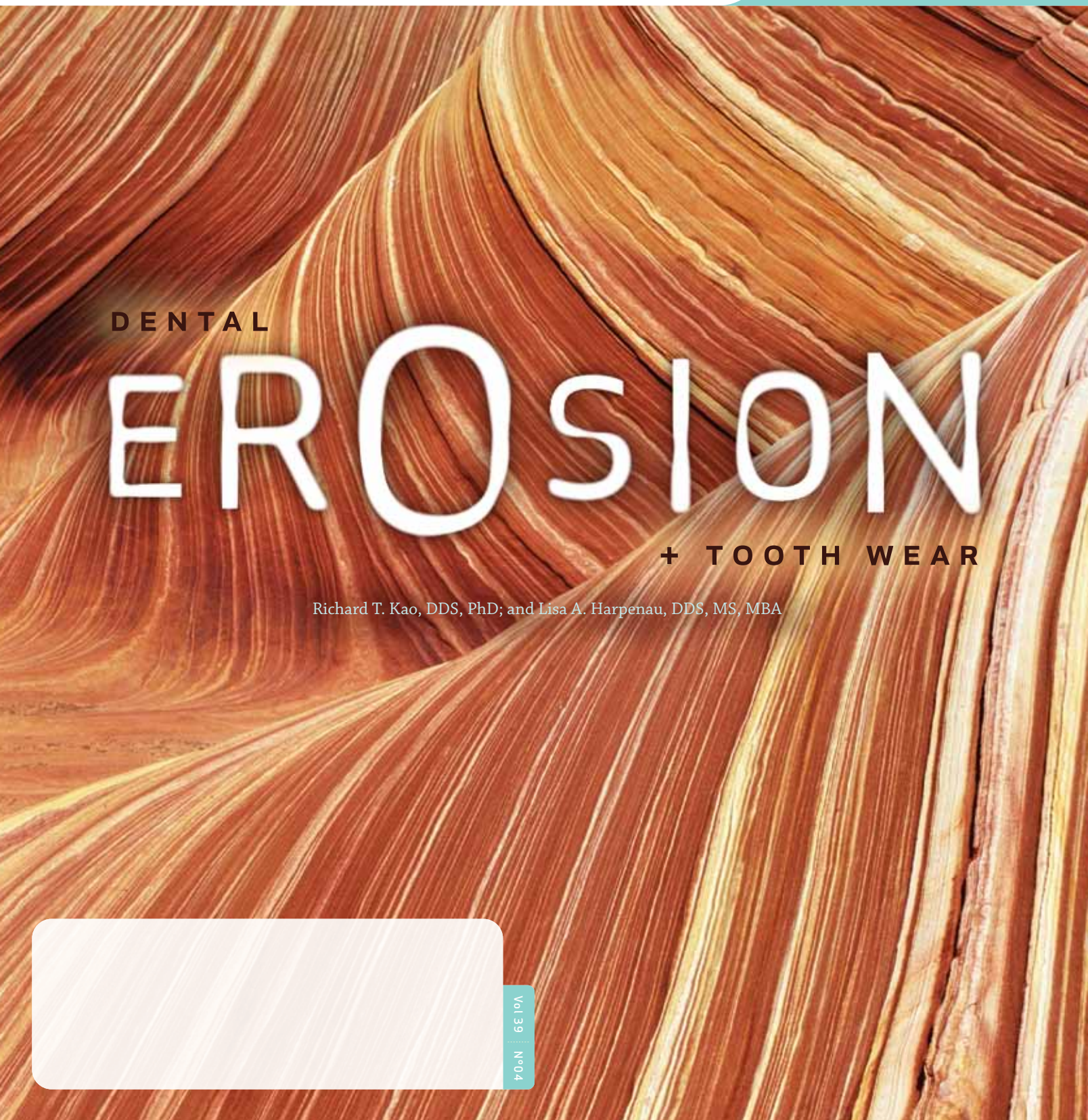
Journal

APRIL 2011

Diagnosis and Management of Dental Wear

Impact of Sports Drinks

Effects of Nutrition



DENTAL EROSION + TOOTH WEAR

Richard T. Kao, DDS, PhD; and Lisa A. Harpenau, DDS, MS, MBA

Vol 39 No 04

Getting all of your insurance through the most trusted source?

Good call.

Protect your business:

TDIC Optimum bundle

- Professional Liability
- Building and Business Personal Property
- Workers' Compensation
- Employment Practices Liability

Protect your life:

- Life/Health/Disability
- Long-Term Care
- Business Overhead Expense
- Home and Auto

Protecting dentists. It's all we do.[SM]

800.733.0633 tdicsolutions.com CA Insurance Lic. #0652783

Coverages specifically written by The Dentists Insurance Company include Professional Liability, Building and Business Personal Property, Workers' Compensation and Employment Practices Liability. Life, Health, Disability, Long-Term Care, Business Overhead Expense and Home and Auto products are underwritten by other insurance carriers and offered through TDIC Insurance Solutions.

tdic®

DEPARTMENTS

201 The Editor/*On the Same Page*

203 Letter to the Editor

207 Impressions

211 Periscope

213 *CDA Presents*

267 Classifieds

276 Advertiser Index

278 Dr. Bob/*Sweet Vengeance Is Like Ice Cream: Best Served Cold*

207

FEATURES

222 **DENTAL EROSION AND TOOTH WEAR**

An introduction to the issue.

Richard T. Kao, DDS, PhD, and Lisa Harpenau, DDS, MS, MBA

225 **DIAGNOSIS AND MANAGEMENT OF DENTAL WEAR**

This paper focuses on the recognition, diagnosis, and general management of dental wear.

Lisa A. Harpenau, DDS, MS, MBA; Warden H. Noble, DDS, MS, MSEd; and Richard T. Kao, DDS, PhD

233 **SPORTS DRINKS AND DENTAL EROSION**

This article is a discussion of sports drinks and how consumption of these beverages may contribute to dental erosion.

Warden H. Noble, DDS, MS, MSEd; Terence E. Donovan, DDS; and Marc Geissberger, DDS, MA

239 **CHANGING DAMAGING BEVERAGE BEHAVIOR: YOUR CDA AT WORK**

This paper presents how CDA and CDA Foundation activities have collectively improved the public's oral health in a multitude of ways.

Gayle Mathe, RDH

243 **THE EFFECT OF NUTRITION AND DIET ON DENTAL STRUCTURE INTEGRITY**

This paper discusses the nutritional and dietary implications on dental structure integrity.

Randy Q. Ligh, DDS, MA; Joseph Fridgen, DDS; and Claire Saxton, MS, RD, CNSC

251 **INTERACTION OF DENTAL EROSION AND BRUXISM: THE AMPLIFICATION OF TOOTH WEAR**

This paper discusses dental erosion and bruxism and its effect on tooth structure.

Craig A. Pettengill, DDS

259 **DECISION-MAKING IN THE MANAGEMENT OF THE PATIENT WITH DENTAL EROSION**

This article outlines clinical examples of patients with dental erosion that highlight the strategy of early identification, patient education, and conservative restorative management.

Donald A. Curtis, DMD; Jay Jayanetti, DDS; Raymond Chu, DDS; and Michal Staninec, DDS, PhD

OF THE CALIFORNIA DENTAL ASSOCIATION

Journal

CDA Journal
Volume 39, Number 4
APRIL 2011

Journal of the California Dental Association

published by the California Dental Association
1201 K St., 14th Floor
Sacramento, CA 95814
800.232.7645
cda.org

Reader Guide:

Upcoming Topics
MAY: *General Topics*
JUNE: *Aggressive Periodontitis*
JULY: *Barriers to Care*

Manuscript Submissions
Patty Reyes, CDE
ASSISTANT EDITOR
Patty.Reyes@cda.org
916-554-5333
Author guidelines are available at cda.org/publications/journal_of_the_california_dental_association/submit_a_manuscript

Classified Advertising
Jenaé Gruchow
TRAFFIC/PROJECT COORDINATOR
Jenae.Gruchow@cda.org
916-554-5332

Display Advertising
Corey Gerhard
ADVERTISING MANAGER
Corey.Gerhard@cda.org
916-554-5304

Letters to the Editor
Kerry K. Carney, DDS
Kerry.Carney@cda.org

Subscriptions
The subscription rate is $18 for all active members of the association. The subscription rate for others is as follows:
Non-CDA members and institutional: $40
Non-ADA member dentists: $75
Foreign: $80
Single copies: $10
Subscriptions may commence at any time. Please contact:
Jenaé Gruchow
TRAFFIC/PROJECT COORDINATOR
Jenae.Gruchow@cda.org
916-554-5332

Permission and Reprints
Jeanne Marie Tokunaga
PUBLICATIONS MANAGER
JeanneMarie.Tokunaga@cda.org
916-554-5330

Journal of the California Dental Association (ISSN 1043-2256) is published monthly by the California Dental Association, 1201 K St., 16th Floor, Sacramento, CA 95814, 916-554-5330. Periodicals postage paid at Sacramento, Calif. Postmaster: Send address changes to *Journal of the California Dental Association*, P.O. Box 13749, Sacramento, CA 95853.

CDA JOURNAL, VOL 39, Nº4

On the Same Page

KERRY K. CARNEY, DDS

Dentists just want to do the right thing. We follow the rules. We stay in the lines. We are conservative by nature. We conserve tooth structure, restore function, and promote oral and overall health.

When it comes to patient safety, we all want to be on the same page. That is why it is so discombobulating to find we are not on the same page with some of our colleagues in medicine.

Take the example of antibiotic prophylaxis. Years ago, when a patient had a medical history that included, for example, mitral valve prolapse (MVP), that was a red flag. Our office team was trained to follow the current recommendations for the prevention of infective endocarditis (IE) published by the American Heart Association (AHA) and endorsed by the American Dental Association (ADA).

We want to give our patients a safe environment for receiving their dental care. We do not want our therapeutic intervention to be the cause of a life-threatening infection. We follow the recommended guidelines for antibiotic prophylaxis. We prescribe the recommended regimen even though we learned in dental school that there did not appear to be scientific evidence to support an antibiotic regimen that targeted a large fraction of the population.

We all want to be on the same page for legal reasons in addition to patient safety. Disregarding the recommendations would be an invitation to litigation should a patient develop an infection after dental treatment.

Disregarding the recommendations would be an invitation to litigation should a patient develop an infection after dental treatment.

The AHA has revised its antibiotic prophylaxis guidelines for dental procedures nine times between 1955, when they were first published, and the 1997 iteration. In the beginning, the basis for the recommendations was not well-established and the quality of evidence was limited to a few case control studies, expert opinion, clinical experience and descriptive studies.[1] Over time, there has been increasing collaboration with other specialties with overlapping concerns for patient safety.

In 2008, a writing group was appointed by AHA to review the 1997 recommendations. The members of the group were chosen for their "expertise in prevention and treatment of … IE with liaison members representing the American Dental Association, the Infectious Diseases Society of America, and the American Academy of Pediatrics."[1] It was found that "the collective published evidence suggests that of the total number of cases of IE that occur annually, it is likely that an exceedingly small number of these cases is caused by bacteremia-producing dental procedures … There should be a shift in emphasis away from a focus on a dental procedure and antibiotic prophylaxis toward a greater emphasis on improved access to dental care and oral health in patients with underlying cardiac conditions associated with the highest risk of adverse outcome from IE and those conditions that predispose to the acquisition of IE."[1]

The updated recommendations produced by the group included four points that pertained to dental procedures.

- Only an extremely small number of cases of IE might be prevented by antibiotic prophylaxis for dental procedures even if such prophylactic therapy were 100 percent effective.
- IE prophylaxis for dental procedures should be recommended only for patients with underlying cardiac conditions associated with the highest risk of adverse outcome from IE.
- For these patients, prophylaxis is recommended for all dental procedures that involve manipulation of gingival tissue or the periapical region of teeth or perforation of the oral mucosa.
- Prophylaxis is not recommended based solely on an increased lifetime risk of acquisition of IE.[1]

The 1997 and 2008 revisions of the recommendations have made for a significant decrease of the number of patients who receive prophylactic antibiotic coverage.

Everyone seems to be on the same page. We are all trying to operate in a safe environment for our patients. We are balancing risk versus benefit for the patient. We are all trying to reduce the potential impact that antibiotic prophylaxis might have on the emergence of microbial resistance.

Now comes the discombobulating part.

A patient comes into the office in 2009 and her orthopedic surgeon has told her she will need to be premedicated before every dental treatment for the rest of her life. I am stymied. The patient had no other contributing factors. I am definitely not on the same page with my colleague in orthopedic surgery.

In 1997, the ADA and the American Association of Orthopaedic Surgeons convened an expert panel of dentists, or-

thopedic surgeons, and infectious disease specialists and published their first advisory statement on "Antibiotic Prophylaxis for Dental Patients with Prosthetic Joints." The panel concluded, "Antibiotic prophylaxis is not indicated for dental patients with pins, plates and screws, nor is it routinely indicated for most dental patients with total joint replacements ... [other than] ... in a small number of patients who may be at potential increased risk of hematogenous total joint infection."[2] It was recommended that antibiotic prophylaxis be considered before invasive dental procedures are performed on dental patients within two years postjoint replacement surgery and on those who have had previous prosthetic joint infections.

This collaborative statement was reviewed, slightly revised, and endorsed by both ADA and AAOS in 2003.[3] Both iterations stated that any perceived potential benefit of antibiotic prophylaxis must be weighed against the known risks of antibiotic toxicity, allergy and development, selection and transmission of microbial resistance.

Now comes the folly of good intentions.

In 2009, the AAOS published an "information statement" that replaced its previous two guidelines and seemed to come from a different page entirely.[4] This information statement asserts, "Given the potential adverse outcomes and cost of treating an infected joint replacement, the AAOS recommends that clinicians consider antibiotic prophylaxis for all total joint replacement patients prior to any invasive procedure that may cause bacteremia."[5] It also removed the two years postsurgery and, instead, advised the precautions should be continued indefinitely.

The statement caused quite a stir and resulted in an interesting interview with a member of the AAOS Patient Safety Committee that developed the statement. The committee was tasked with reviewing and updating the available information. The committee found that it could not agree with the ADA's recommendations on antibiotic prophylaxis because, "Although it is true that no medical evidence exists to support an increased risk of total joint infection in patients undergoing either oral or urologic procedures, neither is there evidence that these patients are not at risk for bacteremia that could result in total joint infection."

I always thought it was impossible to prove a negative in a scientific investigation. This statement seems to give an entirely new meaning to the null hypothesis.

According to the interview, "The original recommendation to stop prophylaxis after two years was based on a single study conducted in 1986. Although the risk might be highest during the first two years, the committee found reasonable data to support the belief that bacteremia from oral procedures may result in total joint infections even several years later. That's why the recommended limit was removed."

To the question: "How do you suggest AAOS members use these recommendations?" The response was, "I'd suggest they print them out and just keep them in the office as a reference. Then, if a patient asks about prophylactic antibiotics before scheduling another type of procedure, the recommendations will be handy."

So now I see what happened. My patient was advised on the basis of the new informational statement that she should have prophylactic antibiotic coverage before any invasive dental treatment for the rest of her life.

Under the present circumstances, dentists are left with the AHA guidelines that decrease the number of patients requiring antibiotic prophylactic coverage and the AAOS statement that increases the number of patients and duration of coverage. We are definitely not all on the same page.

Since all this happened, the *ADA News* has reported that the AAOS and the ADA have begun working together to develop evidence-based guidelines that should be published this year. It is the goal of this collaboration to produce guidelines supported by evidenced-based, systematic reviews that are scientifically sound.

Then we should all be on the same page again. ■■■■

REFERENCES

1. Prevention of infective endocarditis: guidelines from the American Heart Association. *J Am Dent Assoc* 139:3S-24S, 2008.
2. Advisory statement. Antibiotic prophylaxis for dental patients with total joint replacements. American Dental Association; American Academy of Orthopaedic Surgeons. *J Am Dent Assoc* 128(7):1004-8, 1997.
3. Antibiotic prophylaxis for dental patients with total joint replacements. *J Am Dent Assoc* 134(7):895-8, 2003.
4. Information statement antibiotic prophylaxis for bacteremia in patients with joint replacements. AAOS, 2009. aaos.org/about/papers/advistmt/1033.asp. Accessed Feb. 8, 2011.
5. Porucznik Mary Ann, AAOS releases new statement on antibiotics after arthroplasty. http://www.aaos.org/news/aaosnow/may09/cover2.asp. Accessed Feb. 8, 2011.

ADDITIONAL RESOURCES

Pallasch TJ, Antibiotic prophylaxis. Endodontic Topics 2003, 4, 46-59, 2003. 1601-1538. collegeofdiplomates.org/DrLesterQuanDVD200905/ABE%20Part%201%20Written/Endodontic%20Topics%20%20-%20Vol%201%20thru%20Vol%2015/Endodontic%20Topics%20Vol%204/,DanaInfo=www.blackwell-synergy.com%2Bj.1601-1546.2003.00007.pdf. Accessed Feb. 8, 2011.

The Journal of the California Dental Association *welcomes letters from readers on articles that have appeared in the* Journal. *We reserve the right to edit all communications and require that all letters be signed. Letters should discuss an item published in the* Journal *within the past two months or matters of general interest to our readership. Letters must be no more than 500 words and cite no more than five references. No illustrations will be accepted. Letters may be submitted via email to the* Journal *editor-in-chief at kerry.carney@cda.org. By sending the letter to the* Journal, *authors acknowledge and agree that the letter and all rights of the letter's author become the property of the California Dental Association.*

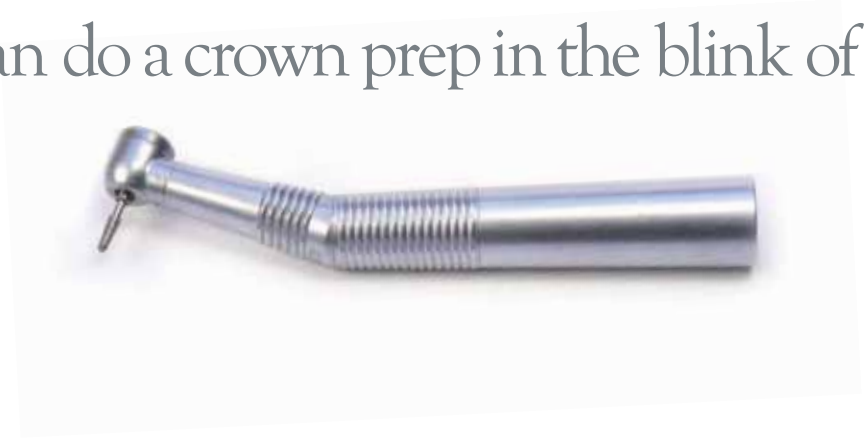
Kudos for 'Barriers to Care' Spotlight

Having read the first two issues "Barriers to Care" in the *Journal of the California Dental Association* (39(1):1-60, 2011 and 39(2):61-124), and especially your editorial on "Controversy, Information, and Passion," my comments are "Bravo!"

The articles demonstrate the fortitude necessary in today's organized dentistry to place all of the cards on the table and via knowledge-based information, develop objective decisions. The articles are great resources for members pursuing the subject, and I compliment the CDA team for their vision.

SAMUEL B. LOW
Gainesville, Fla.

You can do a crown prep in the blink of an eye.



Now let's see if we can help your office staff feel as confident when submitting benefit forms.

A dentist is often only as good as the staff around them. The more your team can do to keep business humming, the more you can focus on patients. To help with that goal, smart dentists register a member of their staff on cdacompass.com. The site is loaded with key resources such as scripts for practice financial protocols and benefit breakdown forms that are sure to have your staff, and your office, running better than ever.

cdacompass.com | where smart dentists get smarter.™

cda PRACTICE SUPPORT CENTER SM

You've built a practice as exceptional as you are. Now choose the optimum insurance to protect it.

TDIC Optimum

Anything but ordinary, Optimum is a professional bundle of products that combines TDIC's singular focus in dentistry, thirty years of experience and generous multipolicy discounts. Creating the ultimate coverage to protect your practice, perfectly. And you wouldn't have it any other way.

TDIC Optimum Bundle

Professional Liability

Building and Business Personal Property

Workers' Compensation

Employment Practices Liability

Protecting dentists. It's all we do.℠

800.733.0633
tdicsolutions.com

Eligible multipolicy discounts apply to Professional Liability, Building and Business Personal Property and Workers' Compensation.

tdic®

CDA JOURNAL, VOL 39, Nº4

Matt Mullin

Drug Aids Bone Grown in Perio Patients

A new University of Michigan study suggests that a drug marketed to osteoporosis patients to grow bone also helps to mend wounds in patients with gum disease.

"This new approach for the treatment of periodontal disease could allow us to rebuild some of the bone that is lost due to periodontal disease, which until this point has been very difficult to achieve," said Jill Bashutski, DDS, MS, clinical assistant professor at the U-M School of Dentistry and first author on the study, which took place at the School of Dentistry's Michigan Center for Oral Health Research. "Current treatments to regrow bone around teeth affected with gum disease have limited success rates."

The findings are significant because gum disease is the leading cause of tooth loss in adults and is associated with a host of

CONTINUES ON 209

Orascoptic Freedom Light

Orascoptic introduces the new Freedom light. This cordless LED headlight system is the first in the industry. It features touch controls, lightweight battery pods, and unprecedented comfort. For more information, go to freedomfromcables.com.

Guiding Children's Behavior in the Dental Setting

Guiding children to cooperate during dental procedures can be a challenge to any dentist, but Jessica Bentoski, DDS, and James Boynton, DDS, offered some helpful tips in the January issue of the *Journal of the Michigan Dental Association*.

In addition to offering guidelines on local and general anesthesia, the authors offer nonpharmacological techniques. These include "tell-show-do," demonstrating to a child exactly what you will do before actually doing it; positive reinforcement, including verbal praise or small rewards; voice control, alternating the tone or volume of your voice to bring attention to something important (it is important to discuss the need for voice control with parents, who may object to the use of a loud or firm voice).

Other communication-based techniques include giving simple, clear directions and not asking a child to do something he or she must do. In other words, when you give a child a choice, such as asking a child in the waiting room, "Are you ready to go back?" is only inviting a negative response. Ask questions such as, "Do you want me to brush the top teeth first, or the bottom teeth first?" Such simple, insignificant, requests give children the impression they have control over some part of the visit. You should also be on guard against any tendency to belittle children with comments like, "You're too old to act that way."

Bentoski and Boynton also urge dentists to question and acknowledge children's emotions. If a child is anxious, acknowledge it, and try to work through it.

CPR Guidelines Are Simplified Again

In many cases, it's best to keep it simple. And so the procedure of cardiopulmonary resuscitation has been streamlined.

The American Heart Association now recommends concentrating on chest compressions, a procedure now known as "hands-only" CPR.

Even if you've never taken a CPR class in your life, if you see someone suddenly collapse, the heart association says to call 911 and then start pushing hard and fast on the person's breastbone — 100 times a minute — until emergency medical technicians or paramedics arrive, according to an article in the *Harvard Health Letter*. It's also important to have someone go get an automated external defibrillator (AED) if one is nearby so you can attempt to shock the heart back into a normal rhythm.

Hands-only CPR before professional help arrives is just as effective as traditional CPR at helping someone survive a sudden shutdown of the heart. People with "non-cardiac" arrest, which usually means they had breathing problems before their hearts went haywire, benefit from traditional CPR: clearing the airways, rhythmic chest compressions and mouth-to-mouth breaths, and repetitive pulse checking.

This is not an unanticipated finding, notes the *Harvard Health Letter*. When the heart association gave its blessing to hands-only CPR, it came with a proviso that conventional CPR techniques might still benefit some people. Children and victims of drowning, trauma, airway obstruction, and acute respiratory disease are mentioned.

To read the original article, go to: health.harvard.edu/newsletters/Harvard_Health_Letter/2010/October/the-simplification-of-cpr?utm_source=health&utm_medium=pressrelease&utm_campaign=health1010.

Correction

Our sincere thanks to Dr. Kogen and all of our readers who advised us of the typo on the cover of the March issue. We apologize for taking the "do" out of "Endodontics."

— Kerry K. Carney, DDS, editor-in-chief

New Research: Bad Habits Resulting in Increase of Throat, Mouth Cancers

Vices, as those practiced by those under the age of 50, are resulting in higher numbers of throat and mouth cancer.

Known as upper aero-digestive tract cancers, these cases have nearly doubled, said researchers who attribute the rise in incidences to excessive drinking, smoking, and poor diet.

In a five-year study, conducted by researchers at Aberdeen University, 350 patients under the age of 50 who had these types of cancers were compared to 400 of their counterparts who did not have the disease. Nine in 10 of the cancers have been linked to drinking, smoking, and an absence of vegetables and fruit in the diet, according to researchers.

"Our study aimed to determine whether smoking, alcohol consumption, and low fruit and vegetable intake remained the most significant risk factors for UADT cancers in this age group, or whether other "novel" factors including genetics and infection could be relatively more important," said Gary Macfarlane, PhD, a professor who led the study. "The results of our study further emphasize that the message we need to be communicating to the public remains the same—that smoking, drinking, and diet are the major triggers of these diseases at all ages."

Nigel Carter, DDS, chief executive of the British Dental Health Foundation, said, "Latest figures show that more than 5,300 new cases a year are diagnosed in the United Kingdom. Action really must be taken to raise awareness and change these figures."

New Web Resource for Keeping a Healthy Smile in Your Golden Years

Get MouthPower is a new web resource for those over the age of 50 to learn about oral health for their specific age group. The interactive website, created by the National Museum of Dentistry along with support from Colgate-Palmolive, provides comprehensive oral health information, such as how the adult mouth changes and what to do about it; the connection between the body and mouth; as well as the unique nutritional issues as one ages.

With a U.S. population of 65 and older anticipated to increase 36 percent from 40 million in 2010 to 55 million in 2020, and more people living longer (averaging 18 years after age 65), oral health is a concern.

"We want this growing segment of the population to become more aware of their health needs and the importance of good oral health," said Jonathan Landers, executive director, National Museum of Dentistry. "Get MouthPower is an engaging resource for older adults to learn about changing oral health issues and options specific to their age group. The more you know, the healthier and happier your golden years will be."

The main areas covered in the web resource (GetMouthPower.org) includes:

Your Sparkling Smile: Oral health tips will help older adults keep their smiles in top condition, including how to address emerging mobility and dexterity issues how to care for implants and dentures, and how to be prepared for dental visits.

About Your Mouth: Tooth color and enamel, gum tissue, and sensation changes as one ages. Find out online what's going on and what can be done about tooth loss, dry mouth, and more. One can also take a risk assessment for oral cancer.

Fit to Eat: Web visitors can check out food tips to boost health, including a calculator to measure daily calcium intake, and an entertaining nutritional boxing bout between your favorite foods.

Kaeser T Series Reciprocating Dental Compressor →

The Kaeser T Series compressor has been redesigned. The T series compressors feature Teflon-coated cylinders for extended equipment life and Kaeser's Seccomat dryer keeps the air clean and dry for composite materials. The fresh ambient air is warmed by compression to refresh the dryer at regular intervals. The Kaeser T series compressor is a reliable source of continuous compressed air for dental practices of up to 12 operatories or seven continuous users. For more information, go to kaeser-dental.com.

BONE GROWTH, CONTINUED FROM 207

other health problems, according to a news release. Periodontal disease results in loss of teeth and can be devastating because it compromises speaking and eating, which in turn contributes to poor nutrition.

Teriparatide is a type of parathyroid hormone and the only anabolic (bone growing) osteoporosis drug approved on the market in the United States. Osteoporosis drugs are designed to thwart loss of bone.

The study, "Teriparatide and Osseous Regeneration in the Oral Cavity," published last year by the *New England Journal of Medicine*, was presented at the annual meeting of the American Society for Bone and Mineral Research in late 2010.

In the study, patients with severe chronic gum disease received traditional treatment for gum disease: periodontal surgery on one-quarter of the mouth. Half of the patients received a six-week course of teriparatide by injection into the skin over the abdomen or stomach, as well as vitamin D and calcium. The remaining patients received a placebo.

After 12 months, a 29 percent improvement in bone-level measurements on X-rays in the teriparatide group was seen by researchers, compared to a 3 percent improvement in the placebo group. The difference was nearly a tenfold increase.

"I think one really interesting aspect of this study is that even a short dosing of this drug had benefits that lasted a year," said Laurie McCauley, DDS, MS, PhD, U-M professor and chair of periodontics and oral medicine, and principal investigator on the study.

For the past 20 years, McCauley's research lab has been studying the parathyroid hormone. According to animal models, parathyroid works better in certain bone wound-healing situations such as those that involve surgery, than in osteoporosis, a diminishing of the bone instead of a wound.

"There was speculation that the bone that forms in a wound like a fracture or inflammatory disease condition might be more responsive to being built back than other bone," said McCauley, who noted that this proved true in the experimental group.

The next step for U-M researchers, McCauley said, is to test whether the treatment could be delivered locally to target site-specific bone healing. Forteo, the brand name, is not FDA approved for uses other than osteoporosis, but another possible application could be to help grow bone around dental implants.

Subscribers to the online version of the *New England Journal of Medicine* may see the article, "Teriparatide and Osseous Regeneration in the Oral Cavity," at nejm.org/doi/pdf/10.1056/NEJMoa1005361.

Regular Dental Care Benefits Women's Heart Health, Study Says

A recent study suggests that women who regularly obtain dental care reduce their chances by one-third of stroke, heart attacks, and cardiovascular issues.

In the analysis, conducted by the University of California, Berkeley, data was used from an estimated 7,000 individuals between the ages of 44 and 88 enrolled in the Health and Retirement Study, according to a news release. The study did not yield similar benefits for their male counterparts.

The study, published online in *Health Economics,* compared people who went to the dentist during the previous two years with those who did not. The findings add to a growing body of research linking oral and cardiovascular health.

"Many studies have found associations between dental care and cardiovascular disease, but our study is the first to show that general dental care leads to fewer heart attacks, strokes, and other adverse cardiovascular outcomes in a causal way," said study lead author Timothy Brown, PhD, assistant adjunct professor of health policy and management at UC Berkeley's School of Public Health.

The longitudinal study followed the same individuals over time, and each biennial survey included questions on whether subjects had visited the dentist and whether they had experienced any heart trouble during the prior two years.

Researchers were not surprised that men did not benefit the same as women obtaining dental care. "To my knowledge, previous studies in this area have found that the relationship between poor oral health and cardiovascular disease markers varies by gender, but none have examined differences between men and women with regard to actual cardiovascular disease events," Brown said.

Mouthwatchers Nano-Silver Antibacterial Toothbrush ↑

The Mouthwatchers Toothbrush is the first toothbrush to utilize nano-silver technology to eliminate germs in the mouth. A normal toothbrush has more than 100 million microorganisms living on its surface, but the Mouthwatcher Toothbrush works synergistically with toothpaste to fight these organisms that cause gum and tooth decay. The colloidal silver content of the Mouthwatcher Toothbrush makes it immune to becoming infested with microorganisms as well as acting as an antibacterial tooth and gum cleaner. For more information about this product, go to mouthwatchers.net.

UPCOMING MEETINGS

2011

April 7–10	California Society of Pediatric Dentistry 36th annual Session/Western Society of Pediatric Dentistry ninth annual session, San Francisco, 831-625-2773, drrstewart@aol.com.
April 10–16	United States Dental Tennis Association, Tampa, Fla., dentaltennis.org.
May 12–14	*CDA Presents the Art and Science of Dentistry,* Anaheim, 800-CDA-SMILE (232-7645), cdapresents.com.
June 9-12	Cleft 2011 International Cleft Lip and Palate Conference, San Francisco, cleft2011icpf.org.
June 16–18	ADA New Dentist Conference, Chicago, 800-621-8099, ext. 2779, ada.org/goto/newdent.
Sept. 22–24	*CDA Presents the Art and Science of Dentistry,* San Francisco, 800-CDA-SMILE (232-7645), cdapresents.com.
Nov. 6–12	United States Dental Tennis Association, Palm Desert, Calif., dentaltennis.org.

To have an event included on this list of nonprofit association continuing education 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.

Periscope offers synopses of current findings in dental research, technology, and related fields.

IMPLANTS

RICHARD T. KAO, DDS, PHD, AND DAVID W. RICHARDS, DDS, PHD

A Systematic Review of Postextraction Alveolar Bone Changes in Humans

Van der Weijden F, Dell'Acqua F, Slot DE, Alveolar bone dimensional changes of postextraction sockets in humans: a systematic review. *J Clin Periodontol* 36(12):1048-58, December 2009.

AIM: Examination of the literature to assess the amount of alveolar remodeling after tooth extraction.

METHOD: A systematic review of MEDLINE-PubMed and the Cochrane Central register control trials up through March 2009. Studies reporting dimensional changes in the alveolar height and width after tooth extraction were included.

RESULTS: Screening resulted in 1244 MEDLINE-PubMed and 106 Cochrane papers. Of these, 12 met the eligibility criteria, which involved random allocation, defined inclusion/exclusion, blinding to patient and examiner, balanced experimental groups, and identical treatment between groups except for intervention and report of the follow-up. The weighted mean reduction in alveolar width was 3.87 mm; a height loss was 1.67-2.03 mm; and a radiographic height loss of 1.53 mm.

CLINICAL RELEVANCE: Appreciation of alveolar remodeling that occurs with extraction is essential for clinicians who need to manage implant placement and prosthetic esthetics in the anterior esthetic zone. This knowledge is essential in avoiding possible clinical problems.

PERIODONTICS

GERALD I. DRURY, DDS

Topical Subgingival Application of Doxycyline is of Limited Benefit in Furcations

Dannewitz B, Lippert K, et al, Supportive periodontal therapy of furcation sites: nonsurgical instrumentation with or without topical doxycycline. *J Clin Periodontol* 36(6):514–22, June 2009.

BACKGROUND: Topical subgingival application of antibiotics is thought to improve the results of nonsurgical periodontal treatment. The aim of this randomized single-blinded controlled clinical trial was to evaluate the clinical effect of topical subgingival application of a 14 percent doxycycline gel adjunctive to SRP at furcation sites during supportive periodontal therapy (SPT).

METHODS: Thirty-nine patients were randomly allocated to either a control group (20 patients) receiving SRP alone or a test group (19 patients) receiving both SRP and application of the doxycycline gel (DOXY). SRP was performed on all pocket depths ≥4 mm. Clinical parameters were determined at baseline, three, six, and 12 months after therapy. Doxycycline benefits were also evaluated as a short-term (three months) improvement of furcation involvement and influence on the frequency of reinstrumentation up to 12 months.

RESULTS: Three-hundred twenty-three furcation sites (class 0, 160; class I, 101; class II, 18; and class III, 44) were treated (SRP, 165; SRP and DOXY, 158). SRP alone exhibited a higher rate of increased furcation involvement after three months than SRP and DOXY. Six and 12 months after baseline treatment, changes of furcation involvement were similar for both treatment groups. Analysis failed to identify SSD between the SRP and the SRP and DOXY group at any examination.

CONCLUSIONS: The use of 14 percent doxycycline gel once as adjunctive to SRP at furcation sites during SPT has a short-term benefit but fails to reduce the frequency of the need for reinstrumentation at furcation sites for a period of 12 months.

BOTTOM LINE: Adjuctive topical doxycyline is of limited benefit in furcations.

CDA JOURNAL, VOL 39, Nº4

TECHNOLOGY

JIN-HO PHARK, DDS, DR.MED.DENT

Reduced Air Pressure for Air-Particle Abrasion Results in Stable Long-Term Bond Strength

Kern M, Barloi A, Yang B, Surface conditioning influences zirconia ceramic bonding. *J Dent Res* 88(9): 817-22, September 2009.

AIM: The aim of this in vitro study was to assess how omitting air abrasion or using reduced air pressure influences zirconia ceramic bonding independent of and in combination with using ceramic primers.

METHODS: Three mechanical surface conditions (polished, air abraded at 0.05 or at 0.25 MPa) and four priming conditions were tested (no priming (NP), priming with metal/zirconia primer (MZP, Ivoclar-Vivadent, Schaan, Liechtenstein), priming with alloy primer (AP, Kuraray Medical, Osaka, Japan), or priming with Clearfil Ceramic Primer (CCP, Kuraray Medical)). After different surface conditioning, zirconia ceramic specimens (Cercon, DeguDent, Hanau, Germany) were bonded and tensile bond strengths (TBS) were evaluated after water storage for three days or for 150 days with additional 37,500 thermal cycles for artificial aging.

RESULTS: Air abrasion of zirconia ceramic surface with 0.25 MPa created a rougher surface than when 0.05 MPa was used, while polishing without air abrasion provided the smallest surface roughness. Specimens, which were not air abraded debonded spontaneously during artificial aging, regardless of primer. On air-abraded specimens, primer groups AP and CCP showed statistically higher TBS than the primer group MZP at each storage time. However, the pressure during air abrasion did not have a significant influence on the bond strength for any of the primer treatments at any storage time.

CONCLUSIONS: The combination of air abrasion and priming improves long-term resin bonding to zirconia ceramic. Low-pressure air abrasion reduces surface roughness without affecting long-term bond strength, provided that adequate adhesive primers were applied.

CLINICAL RELEVANCE: So far, air abrasion seems to be mandatory for durable resin bonding to zirconia ceramic. But high-pressure air abrasion might compromise the ceramic strength by creating surface defects; therefore, omitting air abrasion or using reduced air pressure seems desirable. This study shows that reduced air pressure for air-particle abrasion in combination with appropriate zirconia primers results in stable long-term bond strength. The influence of lower air pressure on ceramic strength still has to be examined.

ENDODONTICS

W. CRAIG NOBLETT, DDS, MS, FACD

Intracoronal Seal and White MTA may Minimize Discoloration Encountered When Performing a Revascularization Procedure

Reynolds K, Johnson JD, Cohenca N, Pulp revascularization of necrotic bilateral bicuspids using a modified novel technique to eliminate potential coronal discoloration: a case report. *Int Endod J* 42(1): 84-92, January 2009.

AIM: This case report presents an alternative technique meant to minimize the discoloration occasionally encountered during revascularization of teeth with immature root formation.

METHODS: Contact with coronal dentin by the minocycline employed in the revascularization procedure is thought to be responsible for the occasional discoloration of teeth undergoing this treatment protocol. In this case report, an 11-year-old female with bilateral dens evaginatus associated with teeth Nos. 20 and 29 was treated using a protocol to seal the internal surface of the coronal dentin prior to the placement of the triple antibiotic paste. The dentin was etched and sealed with an adhesive bonding agent, then further sealed with a flowable composite to the level of the CEJ. The triple antibiotic paste was then applied to the root canal space beyond the composite seal and the procedure completed according to the protocol described by Banchs and Trope (in *J Endod*, 2004). In tooth No. 20, gray MTA was used as the barrier over the blood clot in the canal. In tooth No. 29, white MTA was used as the barrier.

CONCLUSIONS: Following treatment, only tooth No. 20 exhibited a slight gray discoloration at the cervical extent of the crown. This was thought to be due to the use of the gray MTA. Tooth No. 29 exhibited no discoloration.

CLINICAL RELEVANCE: The use of an intracoronal seal and white MTA as a barrier may minimize the chances of the occasional discoloration encountered when performing a revascularization procedure. Care must be taken not to extend the composite into the root canal space, which would compromise the ability to disinfect the dentin.

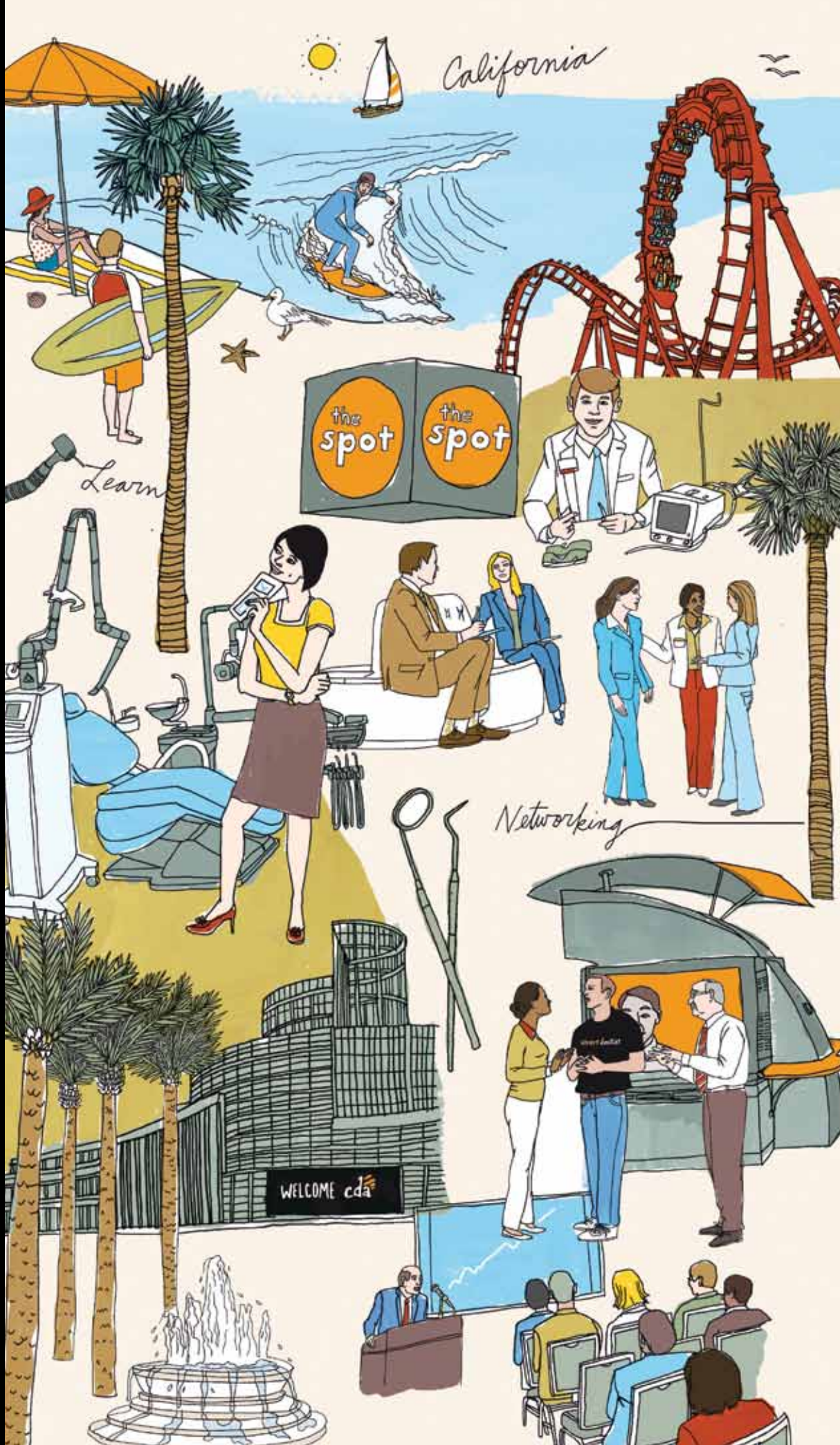
cda PRESENTS

The Art and Science of Dentistry

Anaheim, California

May 12-14, 2011

New days: Thursday-Saturday



This contemporary lounge in the Exhibit Hall features a Cool Product display, an Internet Café and Wi-Fi access, a C.E. Pavilion, and an educational theater, which is debuting the Smart Dentist Series of free, one-hour lectures.

Educational Theater Schedule

Thursday

11 a.m.–noon
Establishing an Office Policy Handbook (C.E./20%)
Robyn Thomason

Noon–1 p.m.
Benefit Plans, Patients and Finances (C.E./20%)
Patti Cheesebrough

1–2 p.m.
Speaker Q and A (C.E./Core)
David Hornbrook, DDS, FACD

Friday

11 a.m.–noon
Making the Best Decisions for Your Practice (C.E./20%)
William Van Dyk, DDS

Noon–1 p.m.
Managing Patient Conflicts (C.E./20%)
Brooke Kozak

1–2 p.m.
Pilates and Seated Stretches for the Dental Professional (no C.E.)
Pilates and Yoga Instructor

Saturday

11 a.m.–Noon
Training Your Staff (C.E./20%)
Teresa Pichay

Noon–1 p.m.
Pilates and Seated Stretches for the Dental Professional (no C.E.)
Pilates and Yoga Instructor

Big changes often start small.

In an effort to do our part for the environment and save our members money, *CDA Presents* will no longer print course handouts for classes in Anaheim and San Francisco. A small effort that will save over 1.3 million pieces of paper each year. Plus, by investing the savings, we can continue to enhance the benefits of *CDA Presents* for members and their teams.

Attendees can access most course handouts at cdapresents.com and are welcome to print them out if they wish. In addition, each show's On-Site Guide will now provide space for note taking. And as always, audio recordings of most classes will be available for purchase at the conclusion of each show. By working together, we can do great things.

cda PRESENTS

Top Tips for Receiving C.E.

- **Plan ahead** — Arrive at least 15 minutes early to all courses, and plan an alternate course in the event that your preferred course is full. Doors close at the start of the lecture, and late arrivals will not be admitted.
- **License numbers matter** — When registering, include the license numbers and formal names of all licensed attendees to ensure C.E. credits are granted.
- **Scan in and out of each course** — Arrival and departure times are used to issue C.E. credits. Scan upon entry and exit, and remain in the course the entire time. Partial credit cannot be granted. Credit cannot be given for overlapping course times or incomplete course attendance.
- **Write down course codes** — During each course, the host will give attendees a three-digit code that should be recorded and saved until you have your complete official C.E. certificate after the convention.
- **Go to the C.E. Pavilion or cdapresents.com after attending class** — At the C.E. Pavilion, you will verify your C.E. units as well as take a brief survey for each course attended. For your convenience, you can wait until you have attended all of your courses to verify, or visit cdapresents.com up to five days after the meeting. Please keep in mind that all courses displayed in the C.E. Pavilion are those that have on-site scan activity and display does not guarantee credit.
- **Print your certificate online** — To make your C.E. certificates available in a timelier manner, **certificates will now be available online approximately three to four weeks after the meeting.** At that time, licensed attendees will receive an email containing a link that will take you to your C.E. certificate. You may also access your C.E. certificate at cdapresents.com. Should you need a copy of your certificate mailed to you, please call 800.232.7645 approximately four weeks after the meeting, and we will be happy to mail you a copy.

Visit cdapresents.com to plan your meeting experience.

Ashtel Oral Care

Visit Booth 652 for your oral care needs. See our Brush Buddies talking timer toothbrushes, the fun way to get kids brushing. Our complete oral care line includes adult, teen, pedo, disposable, and pre-pasted toothbrushes, floss, and oral hygiene kits. Free gift with purchase!

Booth 652 866-274-8351 ashteldental.com

NiteWhite® ACP and DayWhite® ACP

The only take-home whiteners that contain Amorphous Calcium Phosphate. ACP reduces sensitivity, rebuilds enamel, reduces fadeback, and improves luster, to increase patient comfort and satisfaction. Multiple formulas. Eco-friendly packaging. Buy 5, Get 15% Off! Limit 10. Any NiteWhite ACP or DayWhite ACP kit.
*Mention ADV3346

Booth 2326 310-845-8519 discusdental.com

Discover More Lesions & More Revenue

The cordless VELscope Vx Enhanced Oral Assessment System, exclusively distributed through Henry Schein Dental, enhances the health of your patients and practice:

*Helps discover cancerous and other lesions*Exam takes only two minutes*Pays for itself within weeks*Attracts new patients

Booth 2234 631-390-8271 henryscheindental.com

Go Green and $ave Green

Desktop Practice Management Software from Practice-Web for a Paperless Dental Office. $100 OFF with this coupon. FREE iPad with any integrated system.

practice-web™
Paperless Office Solutions

Booth 644 800-845-9379 practice-web.com

Protecting dentists. It's all we do.

tdic®

Visit TDIC at the Member Benefits Center to get a no obligation insurance quote and learn about the ultimate in protection.
Because we were founded by dentists, and protecting dentists is all we do, we're experts on the coverage you'll need to protect your practice and everything else that matters.

Booth 1107 800-733-0633 tdicsolutions.com

Win the New Apple iPad 2!

Name: _____

Address: _____

Phone: _____

Email: _____

Booth 610 888-932-3644 prosites.com

Comprehensive Perio Solution

$150 discount on seminar or self-study tuition. The Perio Protect Method's comprehensive approach to help manage biofilms in periodontal pockets incorporates adjunctive use of customized prescription trays to place solutions into the pockets, preventing the medication from being washed away.

PerioProtect®

Booth 862 877-434-GUMS perioprotect.com

$100 off Loupe and Light Combo

Bring this coupon to SurgiTel booth #660 or #1244 to receive $100 off the show price of any LED light when purchased with a loupe.

Booth 660 734-996-9200 surgitel.com

Be nice to the neighbors

WedgeGuard makes cavity prep:
Faster – no slowing down when breaking the contact
Easier – concentrate on the cavity, not the adjacent tooth
Better – no damage to the adjacent tooth or papilla

Get the WedgeGuard Intro Pack for just $50 – normal price $89!

Booth 134 800-811-3949 triodent.com

Protecting dentists. It's all we do.

Visit TDIC at the Member Benefits Center to learn how we've been protecting dentists for 30 years.

And while you're there, enter to win a $500 Southwest gift card.

Booth 1107 800-733-0633 tdicsolutions.com

15% Off Opalescence Oh! - New Unit Dose Opalescence

Featuring the same award-winning whitening gel as the rest of the Opalescence line, Opalescence Oh! comes in disposable, unit dose capsules with precisely the right amount of gel for one whitening tray. Stop by Ultradent Booth #550 for our 15% off show special!

Booth 550 801-553-4476 ultradent.com

Now if it only came with smarty pants.

Visit CDA's Member Benefits Center and learn how to get your Smart Dentist t-shirt. But hurry, we have a feeling they might go fast.

Booth 1107 866-232-6362 cdacompass.com

$500 Off PBHS Website Design

A better choice, for half the price! Why pay another firm twice as much for a website that performs half as well? PBHS websites help dentists promote their practice, enhance productivity, and educate patients. Visit Booth 771 for a demonstration and $500.00 off our regular website pricing.

Booth 771 800-840-5383 pbhs.com

Grow Your Practice with Invisalign® Take $200 off Introductory Training

Offer Invisalign and watch your practice grow! The first step to becoming an Invisalign provider is to attend Clear Essentials® I. Register for an upcoming course near you during CDA Presents and take $200 off your registration fee. Visit us at Booth #222 today!

Booth 222 866-217-0293 invisalign.com

3M ESPE 1360,1460
A. Titan Instruments 1573
AB Dental USA 1385
Accutron Inc. 560
ACT/Chattem 2518
Acteon North America/Satelec 1174
AD Dental Supply 114
ADA Members Retirement Program 242
AdDent Inc. 1155
A-dec 516
ADM a.s. 2462
Aegis Communications 1772
Affordable Image Dental Marketing 353
Afghanistan Dental Relief Project 870
Air Techniques Inc. 560
Airgas/Littell Industries 1534
ALCO Professional Supplies 1241
All County Construction 680
Allied Systems Products 1122
AllPro 729
Almore International 1328
Al's Dental 1260
AMD LASERS 2524
American Business Card 1753
American Dental Association 2231
American Dental Coders Association 2457
American Dental Software 2446
American Eagle Instruments 855
American Express OPEN 102
American Oral Cancer Foundation 2545
AM-Touch Dental 1373
Anthem Blue Cross 2340
Apixia Inc. 776
Archer Dental Equipment 345
Aribex Inc. 2346
Arm & Hammer 2418
Army Healthcare Professions 2645
Aseptico 1124
Ashtel Dental 474, 652
ASI Medical Inc. 2443
Aspen Dental 2262
Associated Dental Dealers 1260
Association of Managed Care Dentists 128
ATS Dental 1260
Audiology Solutions 2153
Axis Dental Corporation 1661
Azenic 238
Banc of America Practice Solutions 801
Bank of America Card Services 706
Bausch Articulating Papers Inc. 753
Beaverstate Dental Systems 429
Belmont Equipment 1032
Benco Dental 370
Bergman Dental Supply 749
Best Instruments USA Inc. 2461
Beutlich LP, Pharmaceuticals 1545
Bicon Dental Implants 1680
Bien-Air Dental 210
BioHorizons 2062
BIOLASE Technology Inc. 172, 2541
Biotec Inc. 1240
Biotrol 430
Bisco Dental Products 1334
Blatchford Solutions 546
Bosworth Company 1234
Brasseler USA 1144
Brewer Design 1325
Brident Laboratory Inc. 2048
Burbank Dental Laboratory 1752
Burkhart 316
CA Association of Nurse Anesthetists 2555
Cadent iTero 664
California Academy of General Dentistry 254
California Army National Guard 252
California Bank & Trust 122
California Dental Assistants Association 2542
California Dental Hygienists' Association 2540
California Dentists' Guild 1679
California Practice Sales 317
CamSight Co. Inc. 743
Candulor USA 2561
CAO Group 2156
CapitalSource 2464
CareCredit 710
Carestream Dental/Kodak Dental Systems 502
Carestream Health Inc. 402
CariFree 330
Carl Zeiss Meditec 1470
CDA Endorsed Programs 1107
CDA Foundation 1107
CDA Practice Support Center 1107
CDA Publications 1107
CDA Well-Being Program 868
CEJ Dental 1439
Centrix Inc. 616
Certol International 2356
ChaseHealthAdvance 227
Citi Health Card 2460
CK Dental Industries 148
Clarion Financial 371
ClearCorrect Inc 1185
Clinician's Choice Dental Products Inc. 1262
CMC— Fresno General Practice Residency 110
Cochran Dental 1260
Colgate 1316
Coltene/Whaledent Inc. 766
Columbia Dentoform 1160
Common Sense Dental Products 408
Consult-Pro/DHC Marketing Inc. 158
Continental Dental Laboratories 1272
Cosmedent Inc. 721
Cowsert Dental 1260
Crescent Products Inc. 427
Crest Oral-B 1348
Crosstex International 1444
Crown Refining 1784
Crown Seating 1140
CRYSTALMARK Dental Systems 648
Custom Earpiece 239
CustomAir 1160
D & M Practice Sales and Leasing 654
D4D — A Henry Schein Company 2119
da Vinci Dental Studios 859
Dansereau Health Products 1278
Danville Materials/Engineering 1431
Datacon Dental Systems 1359
DCI Equipment 1740
DDS Lab 2144
Delma Canada 1787
Delta Dental 735
Delta Dental Federal Services 741
Demandforce 713, 2342
DenLine Uniforms 879
Den-Mat Holdings LLC 416
Denovo Dental Inc. 747
Dental Board of California 111
Dental Demo Suite 1568
Dental Elite 2141
Dental Forum 873
Dental Equipment Specialist 1260
Dental Health Products Inc. 768

Dental Hygiene Committee of California 2543
Dental Implant Specialties 257
Dental Jobs Only 2052
Dental Lab Owners Association of California 250
Dental Products Report 1377
Dental R.A.T. 885
Dental Technology Consultants 2038
Dental USA Inc. 1760
DentalEZ 1160
DentalEZ Group 1160
DentalGroupBuys.com 2165
Dentalree.com 233
DentalXChange 709
Dentamerica Inc. 777
Dentatus USA Ltd. 586
Dentech Equipment - Alliance H. Inc. 160
Dentex House of Turbines 676
Denti-Cal 739
Denticator 1429
DentiMax Practice Management 2253
Dentis USA 267
Dentistry Today 373
Dentist's Advantage 874
DentLight Inc. 2160
Dentrix — Henry Schein Practice Solutions 2334
DENTSPLY Caulk 1306
DENTSPLY International 1306
DENTSPLY Maillefer 1306
DENTSPLY Professional 1306
DENTSPLY Prosthetics 1306
DENTSPLY Raintree Essix Glenroe 1306
DENTSPLY Rinn 1306
DENTSPLY Tulsa Dental Specialties 1306
Designs for Vision Inc. 846, 1344
DEXIS Digital X-Ray 1646
DiaGold/GoldBurs.com 1685
Diatech 455, 1355
Digital Doc LLC 351
DIO Implant USA 686
DirectCrown Products 2360
Discus Dental LLC 2326
Diversified Dental & Upholstery 1572
DMG America 2230, 2441
DOCS Education 463
DoctorBase 672
Doral Refining Corp. 1224
DoWell Dental Products 1280
Dr. Fresh Inc. 1669
Dr. John's Candies LLC 880
DUX Dental 1216
DXM 380
East West Bank 249
Easy Dental 2134
Econo-Keys 2148
Efficient Dental Technologies LLC 1764
Elavon 704
Ellman International 1526
Elsevier/Mosby/Saunders 1728
Endo Technic 759
Engle Dental Systems 333
Ergonomic Products 362
Esperanza Dental Supply LLC 349
Essential Dental Systems 658
Estrada Dental Supply Co. 774
Evolve Dental Technologies Inc. 2150
EXACTA Dental Direct 751, 1724
Excel National Bank 875
EZ 2000 Inc. 1353
E-Z Floss 1149
First Choice Practice Sales 2551
First Pacific Corporation 1248
Fitzpatrick Dental Equipment 624
Flight Dental Systems 1580
Flossaid Corporation 2126
Flow Dental Corp. 1369
Forest Dental Products Inc. 560
Fortune Practice Management Inc. 650
Galaxy Dental Mfg. Co. 647
Garfield Refining Company 1252
Garrison Dental Solutions 638, 1631
GC America Inc. 1434
Gendex Dental Systems 1428
Genoray America Inc. 2422
George Taub Products 1367
Gingi-Pak 2040
GlaxoSmithKline 2218
Glidewell Laboratories 1476
Global Surgical Corp. 1338
Glove Club 832
Gold Promotions 216
Golden State Construction Inc. 2358
GoldenMisch 2129
Great Lakes Prosthodontics 1485
Greater New York Dental Meeting 1566
GreenerStep 2538
Group Financial Services 431
H & H Company 1748
Hager Worldwide 854
Handler Mfg. Co. Inc. 1623
Hartzell & Son, G. 1321
Hayes Handpiece 632
Head Dental Corporation 1780
HealthFirst Corporation 332
HEINE 772
Henry Schein Dental 2234, 2252, 2459
Henry Schein Professional Practice Transitions 2338
Heraeus 722
High Q Dental 1625
High Speed Service & Kellys Southbay Dental 1260
Hiossen Inc. 276
Hispanic Dental Association 156
Hu-Friedy Mfg. Co. LLC 1406
Hygiene Direct 356
I.B.T. Med LLC 876
ICW International 560
ILS Dental 331
ImageWorks (Dent-X/New Tom) 1480
InfoStar 1673
InsidersCircle.com 755, 2137
Instrumentarium/Soredex 1666
Interactive Diagnostic Imaging 1284
International Education Corporation 2544
Invisalign 222
Isolite Systems 234
iSonic Inc. 1718
ITL Dental 883
Ivoclar Vivadent Inc. 1376, 889
J&J Instruments Inc. 864
J. Morita USA Inc. 748
J. Rousek's GiggleTime Toy Co. 1331
Jordco Inc. 214
JS Dental Mfg. Inc. 620
KAT Implants LLC 670
KaVo Dental 1634
Keating Dental Arts 230
Kerr Corporation 1106, 1206
Kettenbach 142
Keurig Inc. 352
Keystone Industries 202
Kilgore International Inc. 1658
Kimberly Clark Health Care 138
Kings Two Dental Supply 580

Kodak Dental Systems 502
Komet USA 757, 2127
Kuraray America Inc. 2120
L & R Ultrasonics 1222
L.A.K. Enterprises Inc. 1659
Lancer Orthodontics Inc. 1746
Lang Dental Mfg. Co. Inc. 1220
Lares Research 1674
Latinos for Dental Careers 156
Lee Skarin and Associates Inc. 1230
Leica Microsystems 1652
Len Bucko Photo.com 2042
Lester A. Dine Inc. 1558
Lexicomp 1221
Life-Like Cosmetic Solutions 1730
Live Oak Bank 1183
Local Splash 1786
Loma Linda University School of Dentistry 203
LumaDent Inc. 731
LumaLite Inc. 326
MacPractice Inc. 2064
Maddox Practice Group 343
MANI Inc. 328
Market Connections Inc. 2044
Marrott Dental 1260
Marsh U.S. Consumer 877
Marus Dental 1634
Maui Amenities Inc. 2142
Maxdent Dental Supply 1260
McKenzie Management 634
Medelita 2523
Medical Protective 1472
Medicom 341
MedicTalk DentForms Software 113
Medidenta.com 1733
Medikbuild 1687
MegaGen USA Inc. 2128
Meisinger USA 339
Merrill Lynch 2439
Meta Biomed Inc. 2256
Metalift Crown & Bridge Removal System 725
Microbrush International 428
Microcopy 1530, 733
MicroDental, a DTI Laboratory 2318
Micro-Mega/USA 1655
Microtek Lab Inc. 781
Midmark Corporation 308
Miele Inc. 850
Milestone Scientific 1651
Miltex 1516
MIS Implants Technologies Inc. 754
Modular and Custom Cabinets, LTD 560
Monitex Industrial Company 2547
MyRay - Cefla Dental Group 2352
Nadia International Inc. 1554
National Children's Oral Health Foundation 126
National Dental Association 782
Neobiotech 2060
Net32 Inc. 579
Network Experts Inc. 364
Nevin Labs 1160
Nobel Biocare 1180
Nordent Manufacturing Inc. 315
Nouvag AG 578
NuScrubs 481
NuSmile Primary Crowns 1774
Obtura Spartan Endodontics 817
OC Cosmetic Dental Lab 2054
OC-1 Dental Supply Corp. 1776
OCO Biomedical Inc. 478
Officite LLC 2322
One Denture 265
Onpharma 587
Op-d-op Inc. 1621
OralDNA Labs Inc. 2155
OraPharma Inc. 1560
Orascoptic 1106, 1206
Ortho Organizers Inc. 1540
Ortho-Tain Inc. 1716
Osada Inc. 1678
OSHA Review Inc. 608, 630
Pac-Dent International Inc. 872
Pacific Dental Services Inc. 2357
PACT-ONE Solutions 115
Palisades Dental 1722
Panadent Corporation 1524
Panoramic Corporation 1550
Parkell Inc. 756
Patient News 679
Patterson Dental Supply Inc. 434
PBHS Inc. 771
PDT Inc./Paradise Dental Technologies 1758
Pearson Dental Supply 302
Pelton & Crane 1634
Pentron Clinical 1660
Perio Protect LLC 862
PeriOptix Inc. 1226
PHB 727
Philips Sonicare 460
PhotoMed International 2034
Plak Smacker 1349
Planmeca USA Inc. 342
Porter Instrument Company 1240
Porter Royal Sales 1240
Posca Brothers Dental Lab Inc. 266
Practice Transition Partners 367
Practice-Web Inc. 644
Premier Access Insurance Company ..1667
Premier Dental Products Company 1624
Prestige Dental Products 355
Preventech 1641
Preventive Dental Specialties 2442
PreXion Inc. 1681
ProEdge Dental Products 509
Professional Practice Sales 1157
Professional Resource Systems LLC 2437
Professional Sales Associates Inc. 560
Proma Inc. 1240
Prophy Magic 881
Prophy Perfect 2050
ProSites Inc. 1254, 610
Puche Dental Laboratory 1686
Pulpdent Corporation 1759
PureLife Dental 1627, 465
Q-Optics & Quality Aspirators 716, 723
Quality Dental & Upholstery 1487
Quality Systems Inc. 2450
Quantum Inc. 1179
Quantum Products 2344
Quintessence Publishing Co. Inc. 1327
R & D Services Amalgam Separators .1720
RAMVAC 1160
Reliance Dental Mfg. Co. 1276
Replacement Parts Industries Inc. 775
RF America 642
RF America — Video Dental Concepts .246
RGP Inc. 360
Ribbond Inc. 1223
Rode, Chas. W. Inc. 1232
Roque Orthodontic Laboratories Inc. ..1677
Rose Micro Solutions 1639, 2258, 451
Royal Dental Manufacturing 1240
Roydent Dental Products 2046
RX Honing (Sharpening) Machine 1633

Sacramento Dental 1260
Sav-A-Life Systems 2458
Schumacher Dental Instruments 2125
SciCan Inc. 760
Scott's Dental Supply 356
SDI (North America) Inc. 2241
Septodont Inc. 410
Serenity Television 2633
SharperPractice 232
SheerVision Inc. 1645
Shofu Dental Corporation 1128
Sikka Software Corporation 1538
Sirona Dental Systems 734
Six Month Smiles 2124
SleepRight/Splintek 2147
Smile Brands Inc. 2263
Smile Reminder 2225
SNAP Imaging Systems 248
SockIt! Gel 2365
SolmeteX 2139
SOTA Imaging 366
Southland Distribution & Sales 2140
Space Maintainers Laboratory 1370
SS White 1576
Staples Advantage 711
StarDental 1160
State of CA, Dept. of Public Health, Radiologic Health Branch 783
Sterisil Inc. 1270
Sterngold 1258
Straumann USA 480
Suitcase Clinic/Berkeley Free Clinic 268
Sultan Healthcare 1116
Summit Dental Systems 446
Sun Dental Labs 767
Suni Medical Imaging Inc. 2068
Sunwest Bank 1120
Sunstar Americas 1134
SuperMedia 2162
SurgiTel/General Scientific Corp. 1244, 660
Sybron Dental Specialties 1106, 1206
SybronEndo 1106, 1206
Symphony Metals 507
TCS Inc. 860
TDIC 1107, 1330
Technology4Medicine 258
Tekscan Inc. 2260
TeleVox 2434
TePe Oral Health Care Inc. 1779
Tess Oral Health 2133
The Capacity Academy 2149
The Children's Dental Center of Greater Los Angeles 2451
The Kohan Group 2440
The Medi-Kid Company Inc. 887
The Mobile Walkie Talkie Company 1788
TheraSnore by Distar 406
Theta Corporation 1632
THN Enterprises Inc. 369
Tokuyama America Inc. 1336, 223
TopDentists.com 2143
TotalCare 1106, 1206
TPC 260
TR Dental 1177
Tri County Dental Supply 1151
Trident Dental Laboratories 1286
Triodent Corporation 134, 1441, 2421
Trojan Professional Services 1520
TurnKey Dentist 263
Tuttnauer USA 1742
U.S. Bank 1384
U.S. Navy Recruiting Command 106
UCLA Dental Alumni Association 213
UCLA School of Dentistry 215
UCSD Student-Run Free Dental Clinic 2641
Ultradent Products Inc. 450, 550, 2130
Ultralight Optics 780, 1381, 2159
United Concordia Companies Inc. 2445
United States Dental Tennis Association 154
Universal Orthodontic Lab 884
University of the Pacific, Arthur A. Dugoni School of Dentistry 209
Upholstery Packages & Services 2131
US Orthodontic Products 882
USC Ostrow School of Dentistry 211
Valley Dental Supply Inc. 1386
ValuMax International 2135
Vatech America 116
Vector Research & Development 244
Velopex International Inc. 1363
VELscope — LED Dental Inc. 2350
Vericom Co. Ltd. 869
Viade Products Inc. 2435
Victus Capital Wealth 2449
VIDAR Systems Corporation 453
Vident 334
VisiCom 350
Vista Dental Products 1266
VOCO America Inc. 1380
Warren's Professional Service 1260
Water Pik Inc. 1616
Way Beyond Newsletters 2536
Wells Fargo Practice Finance (formerly Matsco) 529
West Coast Precious Metals Inc. 871
Western Dental Services Inc. 2447
Western Society of Periodontology 2453
Western University College of Dental Medicine 207
Whip Mix Corporation 1736
White Towel Services 359
Wiederman & Potter Premium Practice Sales 866
Wykle Research 1635
X Handpiece Systems Inc. 2056
XDR Radiology 2419
Xlear Inc./Spry 2361
Yaeger Dental Supply 1260
Yodle 1768
Young Dental 432
Zest Anchors LLC 1181
Zila, a TOLMAR Company 602
Zimmer Dental 2161
Zirc Company 259
ZOLL Medical Corporation 852

CDA JOURNAL, VOL 39, Nº4

Dental Erosion and Tooth Wear

RICHARD T. KAO, DDS, PHD, AND LISA A. HARPENAU, DDS, MS, MBA

GUEST EDITORS

Richard T. Kao, DDS, PHD, is an adjunct associate professor, Department of Periodontics, Arthur A. Dugoni School of Dentistry in San Francisco, and an associate clinical professor, Division of Periodontology, University of California, San Francisco.

Lisa A. Harpenau, DDS, MS, MBA; is an associate professor, Department of Periodontics, Arthur A. Dugoni School of Dentistry in San Francisco.

Erosive tooth wear is a multifactorial condition that involves acidic dissolution of tooth structure. Unlike carious lesions, which are caused by acid from specific plaque biofilm, erosion is caused by extrinsic or intrinsic acid. Extrinsic exposure is frequently due to consumption of soft drinks, sports drinks, or other acidic beverages. Intrinsic exposure may result from gastric acid, either from gastric esophageal reflux disorder (GERD) or bulimia. The ensuing destruction of tooth structure is characterized by the softening of the enamel and underlying dentin, subsequently resulting in bulk tooth loss. Advanced situations may require endodontic therapy. Since the erosive process is difficult to detect and monitor, the visible progression is often subtle. Erosive damage is amplified when it interacts in concert with abrasion, abfraction, and/or bruxism. This issue will examine the dental impact of dental erosion and its coactive interaction with these other destructive processes.

CDA JOURNAL, VOL 39, Nº4

In the first article, guest editors, Drs. Kao and Harpenau, along with Dr. W. Noble, review the clinical signs, diagnosis, interactions, and general management strategies for dental erosion and other forms of tooth wear including abrasion, abfraction, and attrition.

The next two articles address some of the dental ramifications and public health concerns relative to the pervasive consumption of sports and soft drinks. The first of these two articles by Dr. W. Noble and colleagues discusses how the low pH of sports drinks and their relatively high carbohydrate content can potentially create an erosive environment. Added to dehydration and changes in oral physiology that occur with exercise, excessive consumption of sports drinks may result in erosive damage to the teeth. In the second of these articles, Gayle Mathe (CDA policy development director) describes the efforts that CDA and the CDA Foundation have undertaken to address this public health issue.

The fourth article, by Dr. R. Ligh and coauthors, addresses the need for assessing nutritional intake and dietary habits in patients identified as having problems with dental erosion. Unique to their discussion is how California's multiethnic population requires dentists to understand the dietary habits of cultural groups. As a result, nutritional analysis requires an appreciation of each culture's food pyramid/pattern. Also, exclusive to this article is how dietary counseling should proceed in a dental setting.

The next article by Dr. C. Pettengill describes the interaction of bruxism, clenching, and parafunctional habits with dental erosion. These habits may interact en masse with erosion, compounding tooth wear. The current understanding of the etiology of these parafunctional habits and its management is presented.

Lastly, with patients having advanced dental tooth wear, the clinician is faced with a clinical challenge. At what stage does the dentist proceed with treatment and management? Unfortunately, the "watch and wait" approach is usually not successful. Advanced stages of dental wear can create a restorative challenge. Dr. D. Curtis and colleagues present a GERD case and demonstrate the complexity in rehabilitating a patient with this type of condition. Consistent with the theme of this issue, Curtis et al. describes the best management strategy of early identification, patient education, interceptive care of compounding parafunctional habits, and conservative restorative management.

This issue highlights an aspect of dental disease that can go unnoticed ... until it is too late. With the information provided in the above articles, it is hoped that dentists can more effectively recognize this condition, educate patients, and manage dental erosion and tooth wear problems early and in a conservative manner. ■■■■

CDA JOURNAL, VOL 39, Nº4

Diagnosis and Management of Dental Wear

LISA A. HARPENAU, DDS, MS, MBA; WARDEN H. NOBLE, DDS, MS, MSED; AND RICHARD T. KAO, DDS, PHD

ABSTRACT Dental wear is loss of tooth structure resulting from erosion, attrition, abrasion, and, possibly, abfraction. Clinical /experimental data suggest no single damaging mechanism but rather simultaneous interaction of these destructive processes. The most important interaction is abrasion/attrition potentiated by dental erosion. Awareness of this pathosis is not well-appreciated by the public and dental professionals because the signs may be subtle. This article focuses on the recognition, diagnosis, and management of dental wear.

AUTHORS

Lisa A. Harpenau, DDS, MS, MBA, is an associate professor, Department of Periodontics, Arthur A. Dugoni School of Dentistry in San Francisco.

Warden H. Noble, DDS, MS, MSED, is a professor, Department of Restorative Dentistry, Arthur A. Dugoni School of Dentistry in San Francisco.

Richard T. Kao, DDS, PHD, is an adjunct associate professor, Department of Periodontics, Arthur A. Dugoni School of Dentistry in San Francisco, and an associate clinical professor, Division of Periodontology, University of California, San Francisco.

ACKNOWLEDGMENT

The authors wish to thank Raymond Chu, DDS, for providing clinical photographs for this paper.

Dental wear is a challenging problem for the clinician due to the subtlety of early changes, confusion as to the etiology of the problem, and the dilemma as to when or how to manage the etiology. Unfortunately, the failure to recognize and manage the process often results in inaction until the breakdown is severe. At that point the structural breakdown is so advanced that major rehabilitative treatment is often needed. This journal issue will focus on dental wear and erosion. In this introductory article, the authors discuss the diagnosis and management of dental wear.

Diagnosing and Defining the Tooth Wear Mechanism

Noncariogenic structural tooth loss can be attributed to several causes. In the past these conditions were identified based on the etiologic processes associated with tooth wear (**TABLE 1, FIGURES 1-3**). As such, the destructive force to one of these processes was assigned. Both research and epidemiologic studies tended to have similar monovision. More recently, we are starting to appreciate the interaction between these processes; that is, when more than one of these processes is causing dental wear, the destructive effect is not additive but synergistic. The consensus is that dental erosion potentiates the destructive effects of attrition, abrasion, and abfraction.

Dental Erosion

Dental erosion is tooth structure loss by acid dissolution without bacterial involvement. There are several excellent reviews on this topic.[1-3] The source of acid may be intrinsic (regurgitated gastric acid) or extrinsic (acidic foods such as sports drinks, energy drinks, soft drinks, pickled foods, acidic fruits). Most of our under-

TABLE 1

Definitions of Dental Wear

Dental Terminology	Definition and Etiology	Clinical Appearances
Erosion (FIGURE 1)	Acidic dissolution of tooth structure without the involvement of bacteria	Concavities and cupping on occlusal surfaces resulting in thinning of the enamel Thinning of incisal enamel resulting in increased translucency Wear on nonfunctional surfaces Loss of dental anatomy such as occlusal grooves, cusps, and flat surfaces Dentinal exposure Increased hypersensitivity
Attrition (FIGURE 2)	Loss of tooth structure/restoration due to tooth-to-tooth contact during mastication or via parafunctional habits	Matching occlusal wear between arches Shiny wear facets on restorations Increased risk for fracture of tooth and restorative structure
Abrasion (FIGURE 3)	Loss of tooth structure caused by foreign substances such as toothpastes, toothbrushes, and hard foods	Usually faciocervical concavities that are more broad than deep Can be associated with an abrasive diet Usually found on prominent teeth in the arch (i.e., canines, premolars, and mesiobuccal aspects of first molars) May affect several teeth in a row with a "band" of abrasive damage Increased hypersensitivity
Abfraction (FIGURE 2)	Loss of cervical tooth structure caused by tensile and compressive forces during tooth flexure	Deep, narrow, V-shaped notch in the cervical area (facial aspect) Often affecting a single tooth with excursive interferences or eccentric occlusal loads

*Adapted from Gandara and Wang.[3,1]

standing is limited to erosion of enamel surfaces; however, due to increased interest in dentinal hypersensitivity, more studies are focusing on dentinal erosion.

Mechanistically, enamel exposed to acid loses its mineral form, a layer that extends a few micrometers below the surface. This phenomenon is known as demineralization or softening.[4,5] With time this demineralization extends deeper into the enamel as the superficial layers are lost. Thus, the breakdown is the result of two events: (1) the direct dissolution of the surface enamel layer and (2) the eroding effect that creates a softened and thin, subsurface layer. These events can act synergistically to accelerate tooth wear secondary to mechanical wear (i.e., dental attrition and abrasion). The pH of the tooth can drop in a short, transitory fashion due to a single exposure of an acidic beverage; however, repeated intake may result in dental erosion.[6]

Similarly, swishing or holding the beverage in the mouth can increase exposure time, which translates to a greater erosive effect. This issue is discussed by Dr. Ward Noble in his article on the dental effects of repeated ingestion of sports drinks.

When dentin is exposed to acid, the dissolution of the peritubular and intertubular dentin initially occurs followed by the widening of the dentinal tubules.[7] With the removal of the mineralized dentinal phase, a superficial layer of demineralized collagenous matrix forms. This layer may offer some transient protection from erosive change, but it is very susceptible to mechanical and proteolytic breakdown.

Ultimately, this collagenous matrix is lost, and the erosive process progresses. It has been shown that dentin of both the permanent and primary dentition is equally vulnerable to erosive effects.

Though dentinal erosion is often associated with dentinal hypersensitivity, there is a variety of modulating factors including salivary flow, buffering capacity, electrolyte composition, and protein composition that results in a wide range of clinical susceptibility to dentinal hypersensitivity. The variability of each individual unique pattern of salivary pattern accounts for the variability in dentinal erosion.

Dental Attrition

Attrition is the physiological wear of dental hard tissue due to tooth-to-tooth contact. This may be in the course of normal masticatory function but may also be associated with parafunctional habits such as bruxism or clenching. Clinically the occlusal wear results in a highly polished enamel surface and "matches" the opposing tooth surfaces in wear pattern and facets.

FIGURE 1. Erosion in a patient with a history of bulimia. Note the enamel erosion on both the functional and nonfunctional surfaces.

FIGURE 2. Attrition in conjunction with erosive changes. Note the combination of erosion and attrition on teeth Nos. 4 and 6; attrition as seen on Nos. 7, 8, 9, 10, and 11; and the abrasion on tooth No. 27. A probable cause of the attrition seen on the anterior teeth is due to "posterior bite collapse" or the lack of posterior occlusion to support the vertical dimension.

FIGURE 3. Abrasive changes on teeth Nos. 11 and 12.

In vitro studies have indicated that enamel/enamel attrition under a load of 0.2-16 kg increases relative to loading pressure and contact time.[8,9] Though saliva and salivary mucin proteins can serve as lubricants and decrease wear, the rate of breakdown increases in the presence of water/saline. This is presumptively due to the rinsing away of enamel breakdown products, enabling fresh surfaces to be subjected to additional erosion and functional wear. Once enamel wear is exhausted, the exposed dentin will break down under a lower functional load. The wear rate of the softer dentin, under a lighter load of 6-10 kg, would be similar to enamel-enamel wear under 14 kg.

During normal masticatory function, attrition occurs in concert with abrasion. The type of food and its hardness/abrasiveness will often result in both attrition and abrasive changes. With parafunctional habits such as bruxism, the pathological problem is not only exacerbated by the increased length of time but also by the greater occlusal force that is applied. It should also be noted that attrition can be a functional adjustment to changes in the occlusion. Bruxism and clenching habits have a multifactorial etiology and are discussed separately in this issue.

Dental Abrasion

Dental abrasion is classically associated with compulsive and/or overzealous use of abrasive toothpaste or excessive toothbrushing that results in cervical concavities that are usually more broad than deep.[10] This is often associated with teeth in prominence or in labioversion. Most of our understanding and focus on dental abrasion has been on the abrasive nature of toothpaste, but diet is also a major factor. While Western diets are generally soft and nonabrasive, non-Western diets, including habits such as chewing on betel nuts and ingesting coarse grains/food, may result in abrasive occlusal changes with masticatory function. Thus, not all dental abrasion should be viewed as pathologic or simply attributed to toothpaste/toothbrushing.

In the Western population, abrasion primarily results from the use of toothpaste with toothbrushes. Excellent reviews and summaries of our current understanding are available and will not be discussed in detail in this paper.[11-12] Toothpaste abrasion generally causes more damage to dentin than enamel. When toothbrushing is performed without toothpaste, there is minimal clinical effect on dentin and generally no effect on enamel. Bristle design (thickness, arrangement, finish) can modulate the abrasive nature of the toothpaste. Furthermore, the frequency of brushing, length of time, force applied, and the nature of the dentition can affect the rate of tooth wear. The critical factor is the relative dentin abrasiveness (RDA) of the toothpaste.[13] The International Standards Organization (ISO) index for a standard toothpaste is an RDA of 100. Although there is in vitro correlation of increasing RDA that is associated with greater wear, the relationship is less clear because clinical measurements are variable due to brushing habits, time spent brushing, varying brushing pressure, etc. Nevertheless, clinicians who have concerns for patients with a propensity for dental abrasion should recommend toothpastes with RDA of <100 (**TABLE 2**). It is generally agreed that normal toothbrushing habits with toothpastes that conform to the ISO standard will cause no enamel damage and no significant dentinal abrasion (~1 mm with 100 years of toothbrushing) over a lifetime.

Dental Abfraction

The importance of abfraction as an significant mechanism for tooth wear is inconclusive.[14] Putatively, it has been proposed that the creation of the cervical wedge-shaped or V-shaped notch in the cervical area is due to off-axis loading of a tooth cusp that causes tensile stress concentration around the cementoenamel junction.[15] This leads to microfracture where the enamel tends to breakdown more quickly

TABLE 2

Relative Dentin Abrasiveness of Dental Dentifrices

RDA	Dentifrice brand and variety
04	ADA reference toothbrush and plain water
07	Plain baking soda
08	Arm & Hammer Tooth Powder
35	Arm & Hammer Dental Care
42	Arm & Hammer Advance White Baking Soda Peroxide
48	Arm & Hammer Dental Care Sensitive
49	Arm & Hammer Peroxicare Tartar Control
49	Tom's of Maine Sensitive (given as 40s)
52	Arm & Hammer Peroxicare Regular
53	Rembrandt Original ("RDA")
54	Arm & Hammer Dental Care PM Bold Mint
57	Tom's of Maine Children's, Wintermint (given as mid-50s)
63	Rembrandt Mint ("Hefferren RDA")
68	Colgate Regular
70	Colgate Total
70	Arm & Hammer Advance White Sensitive
70	Colgate 2-in-1 Fresh Mint (given as 50-70)
79	Sensodyne
80	AIM
80	Close-Up
83	Colgate Sensitive Maximum Strength
91	Aquafresh Sensitive
93	93 Tom's of Maine Regular (given as high 80s low 90s)
94	Rembrandt Plus
94	Plus White
95	Crest Regular (possibly 99)
101	Natural White
103	Mentadent
103	Arm & Hammer Sensation
104	Sensodyne Extra Whitening
106	Colgate Platinum
106	Arm & Hammer Advance White Paste
107	Crest Sensitivity Protection
110	Colgate Herbal
110	Amway Glister (given as upper bound)
113	Aquafresh Whitening
117	Arm & Hammer Advance White Gel
117	Arm & Hammer Sensation Tartar Control
120	Close-Up with Baking Soda (Canadian)
124	Colgate Whitening
130	Crest Extra Whitening
133	Ultrabrite
144	Crest MultiCare Whitening
145	Ultrabrite Advanced Whitening Formula
150	Pepsodent (given as upper bound)
165	Colgate Tartar Control (given as 155-165)
168	Arm & Hammer Dental Care PM Fresh Mint
175	Colgate Luminous (given as 150-200)
200	Colgate 2-in-1 Tartar Control/Whitening or Icy Blast/Whitening (given as 190-200)
200	FDA-recommended limit
250	ADA-recommended limit

FIGURE 4. The destruction of the lower anterior teeth involved both erosion and attrition. The interaction can be so destructive as to expose pulp chamber of tooth No. 24.

due to its lower resistance to tensile stress as compared to dentin. It is likely that the clinical signs of abfraction are not simply related to stress concentrations in the teeth; rather, they have a multifactorial etiology.

Interactions Between Tooth Wear Processes

Though it is well-recognized that interactions between different mechanisms exist, determining the primary etiologic agent is difficult. Despite this, the consensus is that the erosive damages are the most important. These interactions have been recently reviewed by Addy and Shellis, and they have noted that there is evidence that suggests erosion can potentiate damaging effects of dental attrition in limited situations.[16] Damage can be so severe as to cause significant structural tooth loss and even pulp exposure (**FIGURE 4**). In vitro studies indicate that dental attrition in the presence of erosion (low pH) or erosive damage will result in greater enamel-enamel breakdown (simulation of mastication between teeth in occlusion) when subjected to the same force as compared to water/saline.[17] However, the pH of the acidity required is associated with that of acid regurgitation of patients with bulimia or gastric reflux (pH 1.2). When the enamel is exposed to a less acidic erosive agent such as acetic acid (pH 3.0) or citric acid (pH 3.2), the relative enamel breakdown during attrition is significantly less.

Dental abrasion is also synergistically more damaging in the presence of erosion.[18,19] The gradient of mineral loss as the result of softening thins the external layer of the mineral crystal making it more

susceptible to the mechanical forces of dental abrasion. It has been suggested that with the abrasive removal of this superficial layer, the inner layer (which has been partially softened) is exposed and thus vulnerable to subsequent acidic challenges.

Abfraction models suggest there are multiple levels of interaction with other tooth wear processes. With exposure to 1 percent lactic acid (pH 4.5), periodic off-axis stressing resulted in an increased erosion of cervical enamel.[20,21] Another finite-element study predicted that if a discontinuity is present at the cervical enamel-dentinal junction, it can create a stress concentration that would exceed the breaking strength of enamel.[22] It has been thought that cervical erosion of the softer dentin can create this discontinuity. This results in the formation of a focal area of structural weakness that may permit the initiation of abfraction.

Since much of the evidence of interaction between wear processes comes mainly from case reports and nonclinical studies, it is difficult to determine the clinical significance of these interactions. This is due in part to the fact that most clinical and epidemiological studies of tooth wear tend to concentrate on only one wear process. The other issue is that since many of these destructive processes occur over a long period of time, the changes are difficult to monitor in a cross-sectional epidemiological study. As such, it is difficult to ascertain the impact of individual wear processes in the overall wear.

Clinical Management of Dental Wear

The damaging effects of attrition and abrasion are often associated with gingival changes such as recession, alterations in biotype, and loss of attached gingiva. Some of these changes can be curtailed or prevented through behavioral modification, oral hygiene instruction, and occlusal adjustment, but correction of the structural damage usually involves gingival grafting and/or the placement of a class 5 composite restoration. Management of pathological attrition as evidenced by bruxism and clenching is discussed in detail in this issue by Dr. Craig Pettengill. Restorative management is described in this issue in the article by Dr. Don Curtis.

It should be clear that of the various mechanisms for tooth wear, dental erosion is singularly damaging but its effects are synergistically potentiated when coincident with attrition, abrasion, and abfraction.[16] The focus of clinical management will be on identifying patients who are at risk for dental erosion, the associated risk factors, and preventive measures.

IF A PATIENT FITS into one or more of the risk groups and dental erosion is present, it is imperative to determine the etiology of the erosion.

Four main groups of patients are at risk for dental erosion. The first group includes adolescent males because of their large consumption of acidic beverages. The aggressive marketing of sports and energy drinks including their subsequent dental impact will be discussed by Dr. Ward Noble. The second group consists of adolescent females affected by bulimia. The third group involves patients with gastroesophageal reflux disease (GERD). The fourth group includes elderly patients who are taking medication(s) that may decrease salivary flow, resulting in xerostomia. Consequently, this makes their teeth more vulnerable to acid attack.

If a patient fits into one or more of the risk groups and dental erosion is present, it is imperative to determine the etiology of the erosion.[1] There are two types of erosion: intrinsic and extrinsic. Intrinsic erosion usually results from gastric refluxate entering the oral cavity secondary to bulimia or GERD. Structural tooth loss is generally evident on the palatal surfaces of maxillary teeth and the occlusal and buccal surfaces of mandibular molars. The second is extrinsic erosion, which is due to an intake of acidic foods (e.g., citrus fruit, vinegar) or acidic beverages. Tooth loss associated with extrinsic erosion occurs mainly on the labial surfaces of the anterior teeth, the buccal surfaces of posterior teeth, and the occlusal surfaces of the mandibular posterior teeth. Enamel dissolution occurs at a critical pH of 5.5.[23] Gastric refluxate generally has a pH <2, whereas citrus fruits and beverages have a pH as low as 1.7. Both of these are more acidic than the critical pH of enamel, and demineralization can occur.

The primary causes of intrinsic erosion are bulimia in adolescent females and GERD in mostly middle-aged males.[24,25] With bulimia the extent of damage is usually present bilaterally and the damage is highly dependent on the amount of time gastric acid is in contact with the teeth. Many bulimic patients are highly aware of the potential of erosive damage and frequently overcompensate with aggressive toothbrushing. Consequently, extensive tissue damage may manifest in multiple areas of gingival recession. With GERD patients the structural tooth loss is often unilateral because the patient routinely sleeps on only one side, causing gastric acid to pool on that side of the mouth. Three clinical signs of GERD are "cupping" of the cusps (pathognomonic for dental erosion), a restoration standing like an isolated island accompanied by

TABLE 3

pH of Some Common Foods

Eggs	7.6–8.0
Corn	6.0–6.5
Oysters	6.1–6.6
Cow's milk	6.3–6.6
Wheat flour	5.5–6.5
Potatoes	5.6–6.0
Squash	5.0–5.4
Bananas	4.5–4.7
Carrots	4.9–5.3
Cherries	3.2–4.0
Oranges	3.0–4.0
Soft drinks	2.0–4.0
Wine	2.8–3.8
Lemons	2.2–2.4

Source of Information: Handbook of Chemistry and Physics, CRC Press.

dissolution of surrounding tooth structure and loss of enamel morphology.

Clinical management of intrinsic erosion is one of diagnosis and counseling the patient. With bulimic patients, it is critical to discuss the damaging effects caused by their habits. Psychological counseling should be recommended. Many of the preventive measures discussed later in this paper should be considered. For patients with GERD, the problem is they may or may not be aware that they have gastric reflux problem as approximately 25 percent of patients have "silent" GERD. These patients should be referred to a gastroenterologist for medical management.

If extrinsic erosion is present, a dietary analysis should be completed. Over a fixed time (usually four days, including a weekend), patients should keep a food diary, making note of all ingested foods and beverages. Foods with very high erosive potential such as fruits, beverages with citric acid, soft drinks, sports drinks, power/energy drinks, sour candies, and those with high vinegar content should be identified (TABLE 3). Also, the dietary analysis should go a step further by focusing on any ethnic foods that may have erosive properties. This may require further questioning and research by the dental professional. Lastly, the manner in which the food is consumed (e.g., chewed, sucked, dissolved in the mouth) will have a varying erosive impact due to the differing mode and time length of exposure. Counseling should encourage diet modification with the purpose of eliminating or minimizing exposure time. Shorter contact time may include eating several small meals over a day. Additionally, it is important to avoid large, highly acidic meals just prior to bedtime.

If left uncorrected, tooth erosion may eventually result in extensive and expensive prosthetic rehabilitation. Thus preventive strategies are critical for decreasing erosive wear. These have been recently reviewed by Wang and Lussi.[1] After identifying the cause of the erosion and providing necessary counseling, dental professionals should consider the following preventive strategies in their patients' treatment plans:

1) *Reduce acid intake.* Recommendations should be made to reduce overall acid intake. Good choices include drinks that have additive amounts of calcium and phosphate that minimize the damage caused by a low pH.

2) *Reduce acidity in the oral environment.* Rinsing with water or proper brushing after acid exposure can minimize its harmful effects. Preventive measures to decrease acidity such as chewing a sugar-free antacid may also be beneficial. Immediately after an acid challenge, patients should be educated to sequentially rinse the mouth with water to eliminate most of the acid, followed by a sodium bicarbonate solution which will neutralize the acid, and lastly with a fluoride mouthwash. This rinsing sequence will help remineralize the acid-exposed surfaces.

3) *Increase salivary flow rate.* Salivary flow with its beneficial buffering properties can be enhanced by the use of a sugar-free antacid, xylitol chewing gum, and/or pilocarpine medication as prescribed and monitored by the dentist/physician team.

4) *Remineralize eroded areas with fluoride and amorphous calcium phosphate.* This includes the use of fluoride varnish, fluoride toothpaste, and amorphous calcium phosphate paste, and eating foods such as cheese and milk, which contain casein, can significantly enhance remineralization immediately after acid challenges.

5) *Reduce abrasion.* The use of a soft bristle toothbrush and non- or low-abrasive toothpaste should be recommended.

6) *Protect exposed dentin with filled resin.* Application of filled dentin adhesive should be applied to exposed dentin. Though it is appreciated that dentin adhesive is weak and can lead to leakage and caries over the long term, it is an inexpensive management for the short-term duration. The alternative of definitive restoration may, at times, not be reasonable during early stages of erosion or too costly for the management of a generalized problem. A follow-up evaluation should be performed to determine if reapplication is necessary.

7) *Fabricate an occlusal nightguard.* For patients who have signs of bruxism or clenching habits, an occlusal nightguard should be considered.

8) *Restore as necessary.* Tooth wear may necessitate restorations at some point. These may be conservative in nature, such as sealants and composites. With extensive generalized damage associated with bulimia and GERD, rehabilitation should be delayed until the etiologic problem is clearly under control and resolved.

Conclusion

Dental wear is a subtle, yet chronic problem that is caused by a variety of processes including erosion, attrition, abrasion, and abfraction. Although each may individually cause tooth wear, the

destructive process may be significantly magnified when erosion is coincident with attrition, abrasion, and/or abfraction. As such, clinicians need to be able to clinically identify tooth wear secondary to erosion, diagnose the type of erosion (intrinsic or extrinsic), address the restorative needs, and institute preventive measures to preclude further damage. The early diagnosis is the key to management of dental wear problem. It is important for dentists and dental hygienists to recognize early signs of dental wear. Early preventive measures as described in other articles in this issue can potentially provide management strategies to avoid dental wear damages. ■■■■

REFERENCES

1. Wang X, Lussi A, Assessment and management of dental erosion. *Dent Clin N Am* 54(3):565-78, 2010.
2. Lussi A, Dental erosion: from diagnosis to therapy. In, Whitford GM, ed., Monographs in Oral Science. Basel S, Karger AG, vol. 20, page 214, 2006.
3. Gandara BK, Truelove EL, Diagnosis and management of dental erosion. *J Contemp Dent Pract* 1(1):16-23, 1999.
4. Koulourides T, Experimental changes of enamel mineral density. In Harris RS, ed., Art and Science of Dental Caries Research. New York, Academic Press, pages 355-78, 1968.
5. Eisenburger M, Hughes J, et al, Ultrasonication as a method to study enamel demineralization during acid erosion. *Caries Res* 3(4):289-94, 2000.
6. Millward A, Shaw L, et al, Continuous monitoring of salivary flow rate and pH at the surface of the dentition following consumption of acidic beverages. *Caries Res* 31(1):44-9, 1997.
7. Meurman JH, Drysdale T, et al, Experimental erosion of dentin. *Scand J Dent Res* 99(6):457-62, 1991.
8. Eisenburger M, Addy M, Erosion and attrition of human enamel in vitro part 1: interaction effects. *J Dent* 30(7-8):341-7, 2002.
9. Eisenburger M, Addy M, Erosion and attrition of human enamel in vitro part 2: influence of time and loading. *J Dent* 30(7-8):349-52, 2002.
10. Imfeld T, Dental erosion. Definition, classification and links. *Eur J Oral Sci* 104(2):151-5, 1996.
11. Bartlett D, Smith BGN, Definition, classification and clinical assessment of attrition, erosion and abrasion of enamel and dentine. In Addy M, Embery G, et al, eds., Tooth Wear and Sensitivity: Clinical Advances in Restorative Dentistry. London, Martin Dunitz Ltd, pages 87-92, 2000.
12. Hunter ML, Addy M, et al, The role of toothpastes and toothbrushes in etiology of tooth wear. *Int Dent J* 52:399-405, 2002.
13. Philpotts CJ, Weader E, et al, The measurement in vitro of enamel and dentine wear by toothpastes of different abrasivity. *Int Dent J* 55(3 suppl 1):183-7, 2005.
14. Litonjua LA, Andreana S, et al, Noncarious cervical lesions and abfractions: a re-evaluation. *J Am Dent Assoc* 134(7):845-50, 2003.
15. Lee WC, Eakle WS, Possible role of tensile stress in the etiology of cervical erosive lesions of teeth. *J Prosthet Dent* 52(3):374-80, 1984.
16. Addy M, Shellis RP, Interaction between attrition, abrasion, and erosion in tooth wear. In Lussi A, ed., Dental Erosion: From Diagnosis to Therapy. Basel S, Karger AG, pages 17-31, 2006.
17. Kaidonis JA, Richards LC, et al, Wear of human enamel: a quantitative in vitro assessment. *J Dent Res* 77:1983-90, 1998.
18. Davis WB, Winter PJ, The effect of abrasion on enamel and dentine after exposure to dietary acid. *Br Dent J* 148(11-12-):253-6, 1980.
19. Jaeggi T, Lussi A, Toothbrush abrasion of erosively altered enamel after intraoral exposure to saliva: an in situ study. *Caries Res* 33(6):455-61, 1999.
20. Grippo JO, Abfractions: a new classification of hard tissue lesions of teeth. *J Esthet Dent* 3(1):14-9, 1991.
21. Grippo JO, Simring M, et al, Attrition, abrasion, corrosion and abfraction revisited. *J Am Dent Assoc* 135(10):1109-17, 2004.
22. Rees JS, Hammadeh M, Undermining of enamel as a mechanism of abfraction lesion formation: a finite element study. *Eur J Oral Sci* 112(4):347-52, 2004.
23. Zero DT, Etiology of dental erosion — extrinsic factors. *Eur J Oral Sci* 104(2):162-77, 1996.
24. Hazelton LR, Faine MP, Diagnosis and dental management of eating disorder patients. *Int J Prosthodont* 9(1):65-73, 1996.
25. Bartlett DW, Coward PY, Comparison of the erosive potential of gastric juice and a carbonated beverage drink in vitro. *J Oral Rehabil* 28(11):1045-7, 2001.

TO REQUEST A PRINTED COPY OF THIS ARTICLE, PLEASE CONTACT
Richard T. Kao, DDS, PhD, 10440 S. De Anza Blvd., Suite D1, Cupertino, Calif., 95014.

the **Herman Ostrow School of Dentistry** of USC

USC UNIVERSITY OF SOUTHERN CALIFORNIA

June 2011

Endodontics from A to Z

Hands-On Program

FACULTY: Dr. Ilan Rotstein, Dr. Thomas Levy, Dr. James Simon, Dr. Samir Batniji, Dr. Yaara Berdan, Dr. Daniel Kolzet, Dr. Stanley Malamed, Dr. Samuel Oglesby, Dr. Daniel Schechter, Dr. Louis Schwarzbach, Dr. Tota Shimizu, Dr. Anthony Tran

PART I *- FRIDAY - SUNDAY, JUNE 3 - 5, 2011 • 9:00AM - 5:00PM.*
PART II *- FRIDAY - SUNDAY, JUNE 17 - 19, 2011 • 9:00AM - 5:00PM.*

This comprehensive state-of-the-art course includes series of seminars and hands-on workshops specially designed for General Dentists who wish to advance their knowledge and clinical skills in the art and science of endodontics. A team of endodontic specialists from Herman Ostrow School of Dentistry of USC will thoroughly discuss evidence-based clinical and biological concepts of modern endodontic therapy. These experts will walk you, from start to finish, through all the necessary steps and phases that will enable you to enhance the way you practice endodontics so you can provide the best standards of endodontic care to your patients.

• LIMITED ATTENDANCE •

August 2011

Hawaii Travel & Learn Program

Travel Program

FACULTY: Dr. Avishai Sadan, Dr. Sillas Duarte

MAUI *- SUNDAY - WEDNESDAY, AUGUST 1 - 4, 2011 • 8:00AM - 12:00PM.*

Join us for the 37th Annual Review of Continuing Education in Dentistry. The theme for this year is: *Comprehensive Esthetic Dentistry: From Risk Assessment to Recipe for Success*. Restorative dentistry and dental materials underwent many substantial and exciting advancements during the last decade. In this course, participants will gain the skills vital to the most applicable and relevant new technologies and techniques. It will be a wonderful opportunity to learn in an intimate environment from two world-renowned experts in restorative dentistry as they present the latest and greatest in adhesive dentistry and materials selection.

• THE HYATT REGENCY MAUI •

August 2011

Clinical Intravenous Sedation

Live Patient Program

FACULTY: Dr. Stanley F. Malamed, Dr. Ken Reed and USC Faculty

PART I *- THURSDAY - SUNDAY, AUG 4 - 7, 2011 • 8:30AM - 4:30PM.*
PART II *- FRIDAY - SUNDAY, AUG 12 - 14, 2011 • 8:30AM - 4:30PM.*

Seven days (49 hours) of concentrated study in the basics of intravenous sedation for the doctor not previously trained in this technique. The aim of this course is to enable doctors completing it to return to their practices and feel confident in using intravenous sedation on their patients. This course fulfills the dental board requirements for parenteral sedation permits. This is a clinical course requiring the doctor to treat dental patients who are receiving intravenous medications. Considerable time is devoted to the technique of venipuncture and the intravenous benzodiazepines midazolam and diazepam. To make the course truly valuable for your office staff, it is recommended that they be urged to attend along with the doctor. To be accepted in this course, the doctor must have a currently valid basic life support provider level (or higher) card from either the American Heart Association or the American Red Cross plus 3 prerequisite courses provided by USC and held on May 16 - 18, 2011.

• LIMITED ATTENDANCE •

To register, please contact our office at 213.821.2127 or visit our website at www.uscdentalce.org

CDA JOURNAL, VOL 39, Nº4

Sports Drinks and Dental Erosion

WARDEN H. NOBLE, DDS, MS, MSED; TERENCE E. DONOVAN, DDS; AND MARC GEISSBERGER, DDS, MA

ABSTRACT Sports drinks were originally developed to improve hydration and performance in athletes taking part in intense or endurance sporting events. These drinks contain relatively high amounts of carbohydrates (sugars), salt, and citric acid. These ingredients create the potential for dental ramifications and overall public health consequences such as obesity and diabetes. High intake of sports drinks during exercise, coupled with xerostomia from dehydration, may lead to the possibility of erosive damage to teeth.

AUTHORS

Warden H. Noble, DDS, MS, MSED, is a professor, Department of Restorative Dentistry, Arthur A. Dugoni School of Dentistry in San Francisco.

Terence E. Donovan, DDS, is a professor, Department of Operative Dentistry, University of North Carolina School of Dentistry.

Marc Geissberger, DDS, MA, is a professor, Department of Restorative Dentistry, Arthur A. Dugoni School of Dentistry in San Francisco.

Dental erosion is defined as tooth structure loss resulting from acid challenges to the enamel and dentin surfaces[1] (**FIGURE 1**). Carious lesions are produced by the conversion of carbohydrates to acids by acid-producing bacteria. On the other hand, tooth erosion is caused by intrinsic acids (e.g., gastroesophogeal reflux disorder [GERD], bulimia) or extrinsic acids (e.g., soft drinks, sports drinks, acidic foods, wine), all of which result in a demineralization of outer enamel and dentin surfaces. This morphologic change and softening of the tooth surface predisposes it to subsequent wear from abrasion (toothbrushing) and attrition (bruxing) (**FIGURE 2**).

Dental erosion in both adults and children has been estimated to occur in 2 to 18 percent of the population and has been increasing in recent years.[2,3] This rise in erosion is paralleled by an increase in consumption of acidic soft drinks, sports drinks, and energy drinks. For example, data from the University of California, Los Angeles, Center for Health Policy Research has shown that individual average consumption of sugar-sweetened beverages has increased to an amazing 50 gallons per person per year.[4] This escalation in soft-drink consumption has also been associated with a significant rise in obesity and diabetes among both children and adults.[4]

Sports drinks were initially developed to provide hydration and electrolyte replacement for athletes during intense or prolonged exercise. Sales of sports drinks have dramatically increased at rates exceeding 20 percent annually, to a current total sales of $1.5 billion per year.[5] It should

FIGURE 1. Severe acid erosion of teeth Nos. 28-30.

FIGURE 2. Note a combination of acid erosion on the lingual surface and attrition on the labial surface.

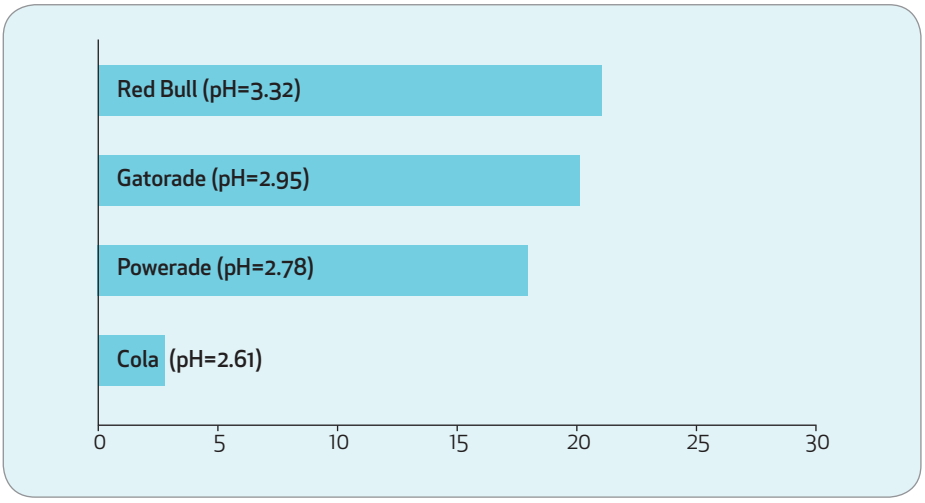


FIGURE 3. Enamel dissolution (mg/cm²).

be noted, however, that most sports drinks are now being marketed to and consumed by individuals not involved in intense exercise or endurance sports. Sports drinks are relatively high in sugar and salt, both of which can contribute to the public health problems of obesity and diabetes in the United States and around the world.[6]

Most athletes do not consume adequate fluids during exercise, which results in dehydration, an increase in body temperature, fluid loss, and possible life-threatening consequences. Proper hydration with the use of sports drinks can improve cardiovascular function, moderate temperature regulation, and improve performance.[7,8] It should be noted that the greatest effect on performance from sports drinks occurs with prolonged, intense exercise over one hour. An interesting study on athletic performance and metabolic balance showed that both water and sports drinks, in equal volumes, were effective with maintaining water, electrolyte and mineral balances, and resulted in equal levels of performance.[9]

The same study found that the voluntary consumption of sports drinks was higher, suggesting that with sports drinks improved levels of hydration could be maintained. This increased consumption of sports drinks is probably related to the improved and more appealing taste, compared to water.[10,11] The main point, however, is that for individuals not involved in intense or prolonged exercise there is little benefit for sports drinks over water.

The Erosive Process

Dental erosion is a complicated, multifactorial process. At the tooth surface level, it is basically a balance of the forces of demineralization and remineralization. As the pH level at the tooth surface drops, calcium and phosphate ions are released from the tooth, resulting in demineralization.[12] As the saturation of these dissolved minerals increases at the tooth surface, supersaturation with calcium and phosphate occurs, pH rises and remineralization can begin.[13]

As noted by Lussi and Jaeggi, there are chemical factors that affect the process of dental erosion such as the pH of the product, type of acid, buffering capacity, and chelating properties from saliva or at the surface of the tooth.[14] The pH of a product is important, as lower pH can cause release of calcium and phosphate from tooth surfaces.

The buffering and chelating properties of different acids are also important.[15,16] For example, the citrate salts from citric acid can bind with calcium at both the tooth surface (with the products of demineralization) and in the saliva, thus reducing the positive effects of the calcium in the reduction of acidity and promotion of remineralization. The calcium and phosphate concentrations in a food or beverage also are important. For example, yogurt has a low pH, but due to the calcium present in the food, there is little or no erosive potential.[17] Fruit juices fortified with calcium are very effective at decreasing the demineralization of the surfaces that are subjected to an acid challenge, which could occur while drinking orange juice.[18]

Biological factors are also important in the erosive process. Tooth surfaces are covered by a biofilm (acquired pellicle) consisting of salivary proteins and glycoproteins. The biofilm serves as a

TABLE 1

Factors Related to Erosive Potential in Sports Drinks

Causes	Results
High acidity (low pH)	↑ Time of low pH = ↑ Demineralization
High buffering (citric acid)	↑ Buffering of tooth surface = ↑ Duration of low pH
Dehydration (xerostomia)	↓ Saliva = ↓ Dilution + slower clearance of acid
Thickness of biofilm	↓ Biofilm thickness = ↓ Protection from acids
Manner of intake	Sipping or swishing = ↑ Time of acid contact
Modifying agent	Calcium can ↓ acidity and rematerialize tooth structure

TABLE 2

Preventive Measures for Acidic Erosion From Sport Drinks During Exercise

Reduce frequency of intake	Use only for rehydration with exercise
Remain hydrated	Dehydration = less saliva - prolonged low pH
Modify manner of drinking	Swallow - do not sip or swish in mouth
Avoid abrasion after acidic challenge	No toothbrushing for at least 30 minutes
Modify pH of acid attack	Use drinks with added calcium = ↓Demineralization
Provide protection from acids and abrasions	Fluoride products, ACP, bonding agents

very important protective layer as the acids must diffuse through it to reach the tooth surface.[19] Thinner layers of biofilm provide less protection.[20] Frequent and prolonged acidic challenges will keep the biofilm pH low, resulting in loss of minerals from the tooth surface.[21]

The saliva flow rate and its buffering capacity are also important. Saliva plays a significant role in the dilution and clearance of erosive substances from the mouth.[22] It also neutralizes and buffers acids, and can help provide calcium and phosphate to further neutralize acids and encourage remineralization. It is probable that the most significant protective effect comes from salivary proteins and glycoproteins, which help create the biofilm that protects the teeth.[23]

Sports Drinks and Dental Erosion

From a dental health perspective, sports drinks are a potential cause of dental erosion and caries, mainly because they contain citric acid and sugars.[6,16] When the pH of saliva drops below 5.5, decalcification of enamel can begin. The amount of decalcification depends on the level of acidity, buffering capacity of the saliva, degree of tritability, and the amount and manner of ingestion of sports drinks[24] (**FIGURE 3**).

Numerous in vitro studies have assessed the risk of acidic beverages in the decalcification of enamel.[15,16,25] In general, lower pH values were associated with more erosion, although Rees reported that length of exposure time was not proportional to the severity of erosion.[26] What may be more significant is the buffering capacity of the citric acid. The greater the buffering capacity of citric acid, the longer it takes for biofilm on the teeth to return to a normal pH after an acidic challenge. This decrease in clearance of acids in the biofilm results in prolonged low pH values and greater potential for erosive damage.[23] It is also probable that with prolonged low pH values in the biofilm (dental pellicle) on teeth, proliferation of additional acidigenic bacteria is encouraged, resulting in the possibility of further erosion and caries.[27]

The enamel dissolution from sports and energy drinks has been shown to be 3 to 11 times greater than that from cola drinks[16] (**FIGURE 3**). This difference may be attributed in part to the presence of larger amounts citric acid (versus phosphoric acid found in cola drinks), which has both the ability maintain the acid levels at the tooth surface (buffering) and to form chelating complexes with calcium. As more calcium is bound up (chelated) the supersaturation of calcium in biofilm decreases, resulting in more removal of minerals from the tooth surface. Together, these processes work synergistically to maintain the pH below threshold values for demineralization.[12,28]

Exercise and Hydration

In addition to the erosive properties of sports drinks, other factors can influence tooth erosion in athletes. During prolonged exercise, especially in hot weather, there is significant loss of fluids through perspiration.[7] Athletes taking part in endurance (cycling, trail running, cross-country skiing) or intense (hockey, basketball, football) sports can lose as much as 1.5 liters of fluid per hour during exercise.

This loss in fluid is also accompanied by a loss of electrolytes, which can also have a negative impact on performance.[8] Additionally, as dehydration occurs there is a decrease in the rate of saliva flow as well as a decrease in the concentration of salivary proteins.[29]

This decrease in saliva results in xerostomia, which results in less dilute saliva and slower clearance rates and less dilution of erosive drinks. A decrease in saliva is also detrimental in that there is less buffering effect from the calcium and phosphate ions that are normally present in the saliva.[23] Another study showed that the tartness (from citric acid) of

FIGURE 4. Erosion from acidic drinks on the labial and lingual surfaces.

FIGURE 5. Preoperative view of extensive erosion. This was caused by a combination of GERD and intake of acidic drinks.

FIGURE 6. Postoperative view of restored teeth.

acidic drinks actually causes an immediate stimulation and increase in saliva, which lowers the acidity at tooth surfaces. However, this effect is of short duration and repeated or constant intake of acidic beverages can keep the acidity at high levels and promote demineralization.[23]

It has also been reported that acid reflux occurs during strenuous or prolonged exercise, especially when accompanied by dehydration. GERD, especially in the presence of xerostomia, results in a severe acid challenge to the teeth.[30]

The method by which sports drinks are consumed during exercise may also contribute to dental erosion. During athletic events such as cycling, cross-country skiing or trail running, liquids are often consumed by sipping from a water bottle or from increasingly popular "hydration packs" where fluids are sipped in small quantities through a tube.

Drinks that are sipped or swished have greater erosive potential because the teeth are subjected to a lower pH for a prolonged period. Conversely, gulping drinks resulted in much smaller changes in pH, as the drinks cleared the oral cavity more quickly.[31] It was suggested that drinking acidic beverages through a straw positioned posteriorly in the mouth resulted in less lowering of the pH.[32,33] One study noted that the biofilm (acquired pellicle) thickness varies in different areas of the mouth. In a "high erosion" group, there was thinner biofilm thickness on the lingual surfaces of upper incisor teeth and greater amounts of erosion compared to other groups in the study. Since biofilm provides a protective layer on the enamel, it appears that there was less protection against erosion in areas of thin biofilm.[20] This may also potentiate increased demineralization when patients are sipping or swishing acidic drinks, resulting in a longer retention and exposure time. Another study noted that the abrasive action of the tongue may also remove, by abrasion, tooth structure from these already softened teeth.[34]

In two in vivo studies, different groups of athletes were examined for dental erosion. Self-reporting questionnaires were used to assess the use and duration of sports drinks. It was found that there was no significant relationship between sports drinks use and dental erosion. However, the authors cautioned that due to the complex and multifactorial nature of dental erosion, more studies of the relationship of sports drinks and dental erosion are necessary.[35,36] It is clear that the acidic nature of sports drinks combined with the conditions under which sports drinks are consumed may have a detrimental effect on teeth (**FIGURE 4**).

In addition to the erosive effects on enamel and dentin, there are also effects from low pH on restorative materials. Studies showed that specimens of a glass ionomer would dissolve in solutions of apple and orange juice.[37] Also, surface softening took place with specimens of resin-modified glass ionomer, compomers (polyacid modified composite resins), and hybrid composite resins.[38] A study with dental porcelains showed that prolonged periods of acid exposure can cause etching and increased roughness of the glazed porcelain surface.[39] Wang and Lussi have pointed out that, due to the susceptibility of restorative materials to acidic challenges, it is necessary to continue preventive measures, even after restorative treatment.[1] It appeared that restorative materials, in the presence of acids, are susceptible to increased surface roughness, decreased surface hardness, and loss of overall volume. This is essentially the same series of events that occur with any intake of acidic beverages.

Treatment

Management of dental erosion has been discussed in detail an article by Harpenau, et al. With respect to sports drinks and dental erosion, early diagnosis of erosive changes and a program to modify patient behaviors are most important.

Early diagnosis is the key to management of this problem. It is incumbent on dentists and hygienists to recognize early erosive changes. Once recognized, the etiology of these changes must be identified. As the dentist-patient relationship develops, information about a patient's personal activities should be gathered. For example, any patient who reports participation in sports activities should be asked about use and frequency of sports drinks. Additionally, patients should be asked about the amounts and methods of drinking these beverages. Preventive strategies can then be developed.

Sports drinks containing increased calcium content, including formulations of amorphous calcium phosphate

(ACP), have been shown to reduce erosivity without affecting taste.[40,41] These ingredients are beginning to appear in consumer products.

Dental offices can also help by applying or prescribing topical fluorides and ACP solutions for home use. Fluoride varnishes can also be helpful by covering areas of susceptible enamel and dentin. The application of composite bonding agents to eroded teeth has been shown to provide protection from erosion for three to six months.[42] Finally, extensive restorative procedures may be needed to replace missing tooth structure (**FIGURES 5 AND 6**).

Behavioral changes are also necessary. Patients should be advised that sports drinks pose many of the same risks as other sweet acidic drinks and they should not be substituted for water (**TABLE 2**). They should also be advised that maximum benefit from sports drinks is derived from their use for rehydration during endurance or intense exercise and that minimum benefit (versus water) is received during less strenuous activities.

Athletes should be advised to avoid sipping or swishing sports drinks; rather, drinks should be rapidly swallowed (gulped) as this will speed clearance of drinks from the mouth and will allow pH levels to return to normal. It would also be helpful to rinse with water, but the teeth should not be brushed for at least 30 minutes after intake of sports drinks. The use of dairy products will also help to return biofilm to normal pH levels, as the calcium and phosphate in these products help to reduce acid levels of the biofilm at the tooth surface.[43]

Summary

Health care professionals should be aware of the relationship between sweet, acidic beverages and dental erosion. Sports drinks can be important in maintaining hydration in athletes partaking in endurance sports such as cycling and long-distance running. They are also helpful in maintaining hydration in intense sports such as football and basketball.

While sports drinks alone have not been shown to cause acid erosion of teeth, they can play a role in the decalcification process. The combination in sports drinks of low pH and the high buffering capacity of the citric acid has the potential to cause demineralization of tooth surfaces. In addition to the acid attacks to teeth, demineralization is potentiated by the amount and manner of consumption of sports drinks during exercise and by xerostomia and GERD, which are experienced by some athletes during endurance events. Fortunately, strategies are now available to help minimize the effects of sports drinks on dental erosion. ■■■■

DRINKS SHOULD BE rapidly swallowed (gulped) as this will speed clearance of drinks from the mouth and will allow pH levels to return to normal.

REFERENCES

1. Wang X, Lussi A, Assessment and management of dental erosion. *Dent Clin N Am* 54(3):565-78, 2010.
2. Spijker AV, Rodriguez JM, et al, Prevalence of tooth wear in adults. *Int J Prosthodont* 22:35-42, 2009.
3. Jaeggi T, Lussi A, Prevalence, incidence and distribution of erosion. *Mongr Oral Sci* 20:44-65, 2006.
4. Soda consumption and its link to obesity in California. healthpolicy.ucla.edu/pubs/files/Soda%20PB%20FINAL%203-23-09.pdf. Accessed Jan. 24, 2011.
5. Soaring sales for sports drinks. bevindustry.com/Archives_Davinci?article=1839. Accessed Jan. 24, 2011.
6. Coombes JS, Sports drinks and dental. *Am J Dent* 18:101-4, 2005.
7. von Duvillard SP, Braun WA, et al, Fluids and hydration in prolonged endurance performance. *Nutrition* 20:651-6, 2004.
8. Naghii MR, The significance of water in sport and weight control. *Nutr Health* 14:127, 2000.
9. Johnson HL, Nelson RA, et al, Effects of electrolyte and nutrient solutions on performance and metabolic balance. *Med Sci Sports Exerc* 20:26-33, 1988.
10. Boulze D, Montastruc P, et al, Water intake, pleasure, and water temperature in humans. *Physiol Behav* 30:97-102, 1983.
11. Minehan MR, Riley MD, et al, Effect of flavor and awareness of kilojoule content of drinks on preference and fluid balance in team sports. *Int J Sports Nutr Metab* 12:81, 2002.
12. Zero DT, Etiology of dental erosion — extrinsic factors. *Eur J Oral Sci* 104:162-77, 1996.
13. Featherstone JDB, Lussi A, Understanding the chemistry of dental erosion. *Mongr Oral Sci* 20:66-76, 2006.
14. Lussi A, Jaeggi T, Chemical factors. *Mongr Oral Sci* 20:77-87, 2006.
15. Owens BM, The potential effects of pH and buffering capacity on dental erosion. *Gen Dent* 55:527-31, 2007.
16. von Fraunhofer JA, Rogers MM, Effects of sports drinks and other beverages on dental enamel. *Gen Dent* 53:28-31, 2005.
17. Lussi A, Jaeggi T, Zero DT, The role of diet in the etiology of dental erosion. *Caries Res* 38:34-44, 2004.
18. Hughes JA, West NX, et al, Development and evaluation of a low erosive black currant fruit drink. 3. Final drink and concentrate, formulae comparison in situ and overview of the concept. *J Dent* 27:345-50, 1999.
19. Jensdottir T, Holbrook P, et al, Immediate erosive potential of cola drinks and orange juices. *J Dent Res* 85(3):226-30, 2006.
20. Johansson AK, Lingstrom P, Birkhed D, Comparison of factors potentially related to the occurrence of dental erosion in high-and low-erosion groups. *Eur J Oral Sci* 110:204-11, 2002.
21. Wetton S, Hughes J, et al, Exposure time of enamel and dentine to saliva from protection against erosion: a study in vitro. *Caries Res* 40:213-7, 2006.
22. Dodds MWJ, Johnson DA, Yeh CK. Health benefits of saliva: a review. *J Dent* 33:223-33, 2005.
23. Millward A, Shaw L, et al, Continuous monitoring of saliva flow rate and pH at the surface of the dentition following consumption of acid beverages. *Caries Res* 3:44-9, 1997.
24. Ehlen LA, Marshall TA, et al, Acidic beverages increase the risk of in vitro tooth erosion. *Nutr Res* 28(5):299-303, 2008.
25. Hooper SM, Hughes JA, et al, A methodology for testing the erosive potential of sports drinks. *J Dent* 33:343-8, 2005.
26. Rees J, Lyon T, McAndrew R, The acidic and erosive potential of five sports drinks. *Eur J Prosthodont Restor Dent* 13:186-90, 2005.
27. Marsh PD, Dental plaque as a biofilm: the significance of pH in health and caries. *Compendium* 30:76-87, 2009.
28. Davani R, Walker J, et al, Measurement of viscosity, pH and titratable acidity in sports drinks. *J Dental Res* 82:special issue A(abstract No. 326), 2005.
29. Walsh NP, Montague JC, et al, Saliva flow rate, total protein concentration and osmolality as potential markers

Timothy G. Giroux
DDS/Broker

ASK THE BROKER

Question:
What do you predict in the way of practice sales for next year?

Hu C, DDS

The last two years have been slow for practice transitions. Most doctors are holding onto their practices for a few extra years since they are uncertain about the future of our economy. Some have lost equity in their homes and realize that the stock market could experience another 4000 point drop as it did in 2008. The net proceeds on the sale of their practices only result in about two years' worth of income, so why not work a little longer if your health is still good?

Unfortunately, the economy has also reduced gross receipts for most dentists. Not only are lower revenues another reason a doctor may defer retirement, but this also translates into fewer and lower paying associate positions. I remember hearing "doom and gloom" predictions for my graduating class of 1983 due to 15+ % interest rates. Eventually the economy pulled us out of those times. I look back now and feel that my class experienced some of the best times of dentistry. Hopefully the same will be true of the young dentists out there struggling to find a job in these tough economic times.

While the "rule of thumb" multiples for pricing practices remain fairly constant, decreasing revenues translates into lower prices. Lenders are not averaging multiple years to determine value, but are using the standard multiples on the last year's tax return. If the revenues have increased, the lenders are very generous with the loan amounts. If the revenues have decreased by more than 15%, not only will the price reflect the corresponding decrease, they may not even be interested in lending on the practice until the receipts have stabilized.

The good news is there is currently a backlog of dental work being created by patients who are putting off dental care. This corresponds to the backlog of practices that eventually will make their way to the market.

My New Year's wish is that the economy turns around, patients once again seek dental care and doctors decide it is time to retire. If it does not happen this year, hopefully it will happen next year!!! Who knows? This group of graduating dental students may eventually be as lucky as my generation of graduates.

Timothy G. Giroux, DDS is currently the Owner & Broker at **Western Practice Sales (westernpracticesales.com)** and a member of the nationally recognized dental organization, ADS Transitions. Do you have any **Questions? Email them directly to *Dr Giroux at:* wps@succeed.net** or Call **800.641.4179**

of whole-body hydration status during progressive acute dehydration in humans. *Arch Oral Biol* 49:149-54, 2004.
30. Peters HP, Wiersma JW, et al, The effect of a sports drink on gastroesophageal reflux during a run-bike-run test. *Internat J Sports Med* 21:65-70, 2000.
31. Grobler SR, Jenkins GN, Kotze D, The effects of the composition and method of drinking of soft drinks on plaque pH. *Br Dent J* 158:293-6, 1985.
32. Edwards M, Ashwood RA, et al, A videofluroscopic comparison of straw and cup drinking: the potential influence on dental erosion. *Br Dent J* 185:244-9, 1998.
33. Shellis RP, Finke AI, et al, Relationships between enamel erosion and liquid flow rate. *Eur J Oral Sci* 113:232-8, 2005.
34. Gregg T, Mace S, et al, A study in vitro of the abrasive effect of the tongue on enamel and dentin softened by acid erosion. *Caries Res* 38:551-6, 2004.
35. Milosevic A, Kelly MJ, McLean AN, Sports supplement drinks and dental health in competitive swimmers and cyclists. *Br Dent J* 182:304-8, 1997.
36. Mathew T, Casamassimo PS, Hayes JR, Relationships between sports drinks and dental erosion in 304 university athletes in Columbus, Ohio. *Caries Res* 36:281-7, 2002.
37. Aliping-McKenzie M, Linden RWA, Nicholson JW, The effect of Coca-Cola and fruit juices on the surface hardness of glass ionomers and compomers. *J Oral Rehab* 31:1046-52, 2004.
38. Gomec Y, Dorter C, et al, Effects of dietary acids in surface microhardness of various tooth-colored restoratives. *Dent Mater J* 23:429-35, 2004.
39. Kukiattrakoon B, Hengtrakool C, Kedjarune-Leggat U, The effect of acidic agents on surface ion bleaching and surface characteristics of dental porcelains. *J Prosthodont Dent* 103:148-62, 2010.
40. Venables MC, Shaw L, et al, Erosive effect of a new sports drink in dental enamel during exercise. *Med Sci Sports Exerc* 37:39-44, 2005.
41. Ramalingam L, Messer LB, Reynolds EC, Adding case in phosphopeptide-amorphous calcium phosphate to sports drinks to eliminate in vitro erosion. *Pediatr Dent* 27:61-7, 2005.
42. Sundaram G, Wilson R, et al, Clinical measurement of palatal tooth wear following coating by a resin sealing system. *Oper Dent* 32:539-43, 2007.
43. Bartlett D, Etiology and prevention of acid erosion. *Compendium* 30:616-20. 2009.

TO REQUEST A PRINTED COPY OF THIS ARTICLE, PLEASE CONTACT
Warden H. Noble, DDS, MS, Department of Restorative Dentistry, Arthur A. Dugoni School of Dentistry, 2155 Webster St., San Francisco, Calif., 94115.

CDA JOURNAL, VOL 39, Nº4

Changing Damaging Beverage Behavior: Your CDA at Work

GAYLE MATHE, RDH

ABSTRACT The California Dental Association's vision statement places promoting the public's oral health as a top priority of the association. The past 10 years have seen CDA and CDA Foundation activities collectively improve the public's oral health in a multitude of ways. Some have been directed specifically at reducing the detrimental effects the consumption of beverages with high sugar content and carbonation has on oral health.

AUTHOR

Gayle Mathe, RDH, is the policy development director for the California Dental Association.

The California Dental Association's vision statement, to be "the recognized leader for excellence in member services and advocacy promoting oral health and the profession of dentistry," places promoting the public's oral health as a top priority of the association.[1] In pursuit of this responsibility, in 2001, CDA founded the CDA Foundation as its philanthropic affiliate, with the express mission to "improve the oral health of all Californians by supporting the dental profession in its efforts to meet community needs."[2] These core beliefs, and dentistry's commitment to them, underlie numerous advocacy and programmatic activities of the association over the years.

While the last 10 years have seen CDA and CDA Foundation activities collectively improve the public's oral health in a multitude of ways, some have been directed specifically at reducing the detrimental effects the consumption of beverages with high sugar content and carbonation has on oral health. Early in this decade, as the scientific and public health communities began to focus on the impact that the soaring consumption of sugar-laden drinks was having on childhood obesity, it was also becoming clear that these poor beverage choices were damaging America's oral health as well.

In 2002, the California Legislature began to receive proposals from non-dental stakeholders to limit the sale of sugary beverages in schools. In 2003, Sen. Deborah Ortiz authored Senate Bill 677, which was successful in limiting soft drink sales on elementary school campuses.[3] CDA worked with Sen. Ortiz to educate the Legislature that the concern is not just related to obesity, but also for children's oral health. With this legislation in hand, CDA launched a "Sip all Day, Get Decay" public awareness campaign. Originating in Michigan and Wisconsin, CDA brought this campaign of 30-second

radio public service announcements and colorful posters to California to educate the Legislature and the public on the effects that high sugar, carbonated beverages were having on oral health. This campaign brought a strong message that frequent consumption, both quantity and duration, of soft drinks and other acidic beverages can have a deleterious effect on oral health (**FIGURE 1**).

Over the years, as legislative bills were introduced in an attempt to reduce children's soda consumption by limiting soda sales at school, the 2006 CDA Policy Development Council initiated policy to define and ensure support of these efforts. This culminated in the CDA House of Delegates adopting policy supporting several strategies to encourage behavior change, including disclosure of nutritional information; restrictions on the marketing and availability of products of low nutritional value and high sugar/calorie content, "especially to children while their care is entrusted to public and private entities"; and "marketplace interventions, such as product specific taxation."[4]

Despite legislative activity throughout the 2000s, rates of decay in, and soda consumption by, children soared, while public funding for oral health programs shrunk. CDA began considering innovative ideas to reduce high carbohydrate drink consumption by placing a fee on the syrup used to manufacture soda and energy drinks. The goal was twofold, to reduce consumption and provide additional funding for children's oral health programs. In support of this effort, the 2008 CDA House of Delegates adopted Resolution 28, directing the association to pursue the enactment of a manufacturer's fee on the syrup used to produce soda, sport, and energy drinks.[5] The rationale for pursuing a fee over a tax was driven by the fact that tax-generated revenue goes to the general fund and can be spent as the Legislature directs. Funds generated by fees go directly to mitigate the effects of the product's use – in this case, to improve oral health. The decision by the CDA House launched groundbreaking efforts to establish the legal arguments and economic modeling necessary to support the nexus between soda and dental caries in a way that meets the requirement in California for a "fee" to be levied on a particular product, paving the way for a future political effort.

FIGURE 1. A flier CDA created for a public awareness campaign about the effect of sugary carbonated beverages on teeth.

Most recently, CDA worked with program developers of a new campaign, "Sugar Savvy, Rethink Your Drink," to ensure inclusion of oral health in campaign materials.[6] This campaign highlights the dangers of high sugar, carbonated drink consumption and provides materials to professionals to educate their patients and the public on hidden sugars and the negative impact they have on health. The 2010 *CDA Presents the Art and Science of Dentistry* in San Francisco

brought this campaign to California dental professionals and provided them with materials they can use in their offices and communities to raise awareness. CDA will sponsor the program again at the 2011 *CDA Presents* in Anaheim.

CDA's ongoing commitment to improve the public's oral health through reduced soda and sugary beverage consumption is evident in this brief review of some of the association's projects. With a clear indication that oral health disparities persist, CDA will continue efforts to educate the public and policymakers and identify programs, projects, and policies that improve California's oral health. ■■■■

REFERENCES

1. California Dental Association vision statement. cda.org/about_cda/missions,_visions_&_core_values. Accessed Jan. 24, 2011.
2. California Dental Association Foundation mission statement. cdafoundation.org. Accessed Jan. 24, 2011.
3. Senate Bill 677, Ortiz. The California Childhood Obesity Prevention Act. leginfo.ca.gov/pub/03-04/bill/sen/sb_0651-0700/sb_677_bill_20030917_chaptered.pdf. Accessed Jan. 24, 2011.
4. California Dental Association policy, Behavior Modification Strategies to Improve Oral and General Health, Resolution 17RC-2006. cda.org/library/cda_member/policy/uah/uah_06.htm and cda.org/library/cda_member/policy/policy_manual.pdf (member login required). Accessed Jan. 24, 2011.
5. California Dental Association Resolution 28. cda.org/library/cda_member/policy/uah/uah_08.pdf (member login required). Accessed Jan. 24, 2011.
6. Bay Area Nutrition and Physical Activity Collaborative. banpac.org/resources_sugar_savvy.htm. Accessed Jan. 24, 2011.

TO REQUEST A PRINTED COPY OF THIS ARTICLE, PLEASE CONTACT
Gayle Mathe, RDH, Public Policy, California Dental Association, 1201 K St., 15th Floor, Sacramento, Calif., 95814.

Visit
Booth 2326
at CDA

NiteWhite ACP Turbo and DayWhite ACP 38%

It's about time.

NiteWhite® ACP Turbo and DayWhite® ACP 38% are the only whiteners on the market that deliver the speed patients demand with the added benefits of Amorphous Calcium Phosphate (ACP) technology.

NiteWhite ACP Turbo whitens an average of **6 shades in just 3 nights.*** NiteWhite ACP is a specially formulated peroxide gel with a proprietary activation matrix to extend the release of peroxide overnight.

DayWhite ACP 38% whitens even faster. **Just 15 minutes, twice a day** delivers significant improvement.

Both whiteners also contain fluoride, potassium nitrate, plus ACP to reduce sensitivity and increase patient comfort. **It's about time** your patients experienced a comfortable whitening procedure with amazing results.

Call today:
(800) 422-9448
discusdental.com

NITEWHITE® turbo ACP | DAYWHITE® 38% ACP

DISCUS®
Inspired by you.™

* Data on file. To be dispensed by or on the order of a dental professional only. ADV-3257 031111

CDA JOURNAL, VOL 39, Nº4

The Effect of Nutrition and Diet on Dental Structure Integrity

RANDY Q. LIGH, DDS, MA; JOSEPH FRIDGEN, DDS; AND CLAIRE SAXTON, MS, RD, CNSC

ABSTRACT Nutritional intake and dietary habits affect the structural integrity of the primary and permanent dentition. This happens through the indirect effect of nutrition on tooth development, as well as through the direct effect associated with the erosive characteristics of the diet. Evaluation of a patient's dietary history, coupled with the ability to implement targeted educational strategies relevant to the individual's ethnicity, will ensure success of normal tooth development and dental structure integrity free of erosive effects.

AUTHORS

Randy Q. Ligh, DDS, MA, is staff attending/lecturer, Veterans' Administration Hospital, Palo Alto, Calif., and in private practice in San Jose.

Joseph Fridgen, DDS, is in private practice in San Jose.

Claire Saxton, MS, RD, CNSC, is a clinical dietitian, Kaiser Permanente, Santa Clara, Calif.

The destructive events associated with dental erosion are highly influenced by nutritional patterns. Nutritional intake can affect the soundness of the dental structure during tooth formation, and dietary habits may be a significant factor in leading to dental erosion at the surface level throughout life. Understanding this dual role of nutrition having an effect on both tooth development and the external surface of the teeth underscores the utility of nutritional counseling in the clinical setting.

Interaction of Nutrition and Dental Malformation

Adequate intake of calories and protein, as well as vitamin A, vitamin C, vitamin D, calcium, and phosphorus are essential for proper tooth formation. Maternal nutrition is the first area of concern, as tooth development begins in utero.[1-3] The primary teeth initiate their development between the sixth and eighth weeks, and calcification is completed by the 20th week in utero. Between the 16th and 20th weeks in utero, the permanent teeth initiate their development. All of the permanent teeth have developed and calcification is evident by age 3, except for the third molars.

During the last trimester of pregnancy, a significant amount of the newborn's overall stores of calcium and phosphate are accumulated. As a result, a preterm newborn or one with an extremely low birth weight (<1,500 grams) miss out on the accumulation of calcium, phosphate, and vitamin D.[4,5]

Dental enamel is a highly mineralized tissue of ectodermal origin that lacks any

FIGURE 1. Hypoplasia of teeth. *Reprinted with permission by Mosby/Elsevier.*

FIGURE 2. Hypocalcification of teeth. *Courtesy of Drs. Randy Ligh and Joseph Fridgen.*

metabolic activity once formed. Disturbances during development, including inadequate nutrition, will reflect as permanent defects in the erupted tooth. Insults during the initial matrix secretion phase of amelogenesis will reflect as quantitative or morphologic defects (hypoplasia) (**FIGURE 1**). Insults during the calcification or maturation processes will reflect as qualitative defects[6-8]: hypomineralization or hypocalcification (**FIGURE 2**).

Enamel defects have been noted in the literature in 5.9-33 percent of "normal" children and in up to 77 percent of children from "underdeveloped" countries. These defects have been associated with a multitude of systemic disturbances, but nutrition is included as part of the differential etiology.[9-11]

While protein calorie malnutrition is rare in American children without chronic diseases, inadequate intakes of some of these micronutrients pivotal to tooth formation are more common. The Centers for Disease Control conducts continuous surveys of the population called the National Health and Nutrition Examination Survey (NHANES) that provide valuable data on the health and nutrient intakes of Americans. According to NHANES data, 17 percent of boys and 33 percent of girls aged 4-8 did not meet the adequate intake for calcium, but only 5 percent had inadequate intakes for those aged 1-3. Intakes for vitamin D were even lower, with 20 percent of boys and 34 percent of girls aged 4-8 not meeting the recommended intake. In addition, 20-25 percent of 1-3 year olds did not meet the AI.[12] (AI is a goal for an individual's intake of a nutrient. These inadequate intakes could contribute to compromised dental integrity either as hypoplasia, hypomineralization, or hypomaturation.

Dietary Habits and Dental Erosion

Dietary habits can have a direct, posteruptive effect on the structural integrity of the teeth. Although the influences of diet can be multifactorial, it is important to note that these are of chemical and physical origin rather than of microbiological origin.[13]

Acidic foods, especially ones with a high titratable acidity, have potential erosive effects. Titratable acidity is a measure of the amount of alkali that needs to be added to neutralize acid and reach a pH of 7.0. The value reflects the amount of available acid — both bound and free ions—and thus the erosive potential of the substance.[14] In contrast, foods with high calcium and phosphate content will not dissolve dental hard tissue. How the food or beverage is consumed is also important, as prolonged or repeated exposure will overwhelm the protective effect of salivary proteins. Foods that are eaten in isolation will lack the balancing effects of other foods.

Beverage intake can be a source of dietary acids (including citric, phosphoric, or acetic acids) that lead to erosive tooth wear. Intake of acidic beverages such as juices and carbonated sodas is common, and these may be taken slowly or sipped frequently throughout the day leading to a high duration of exposure. As can be seen in **TABLE 1**, cola drinks that have a pH of 2.5 have a relatively low titratable acidity at 0.7 g/100ml. Grapefruit juice is less acidic with a pH of 3.2 but has much more titratable acid with a relative value of 9.3 g/100 ml. In this particular case, grapefruit juice has a higher erosion potential than cola.[15] Questions about what beverages are consumed and in what manner (sippy cup, straw, juice box) may lead to opportunities to educate patients on ways to decrease risk of erosion.[16] The use of vitamin C (ascorbic acid) supplements in tablet form has been known to cause significant dental erosion. Vitamin C tablets have a pH of 1.92. Acids are present in many of our foods. The scope of dietary acids in our foods include acetic acid, ascorbic acid, benzoic acid (preservative), citric acid, maleic acid, phosphoric acid, propionic acid (preservative), succinic acid, tartaric acid, and carbonic acid.

Wines, cider, salad dressings, vinegar conserves, acidic fruit-flavored candies are all potential erosive foods. Intake of acidic fruit products (juices, dried fruits and fruit snacks) in the absence of other foods could lead to surface softening (**TABLE 2**). The consistency of a food substance can contribute to the erosive potential. A starchy food substance or thick sticky gels are additive to the erosive potential due to prolonged clearance times. The addition of high calcium and phosphorus foods, such as cheese, milk, or yogurt, would decrease the erosive potential of this type of snack or meal. Studies have shown that the addition of ions, such as iron, calcium, and phosphorus, seems to decrease the erosive potential of acidic solutions.[17] The use of fermented shrimp paste, which is high in calcium and used in Thai foods, can be protective as well.[18]

TABLE 1

Titratable Acidity and Erosion Potential of Drinks

Drinks	pH	Titratable acidity (g/100ml)	Erosion potential
Sparkling water	5.3	0.1	Low
Orange juice	3.8	4.5	High
Apple juice	3.2	4.5	High
Grapefruit juice	3.2	9.3	High
Carbonated orange soda	2.9	2.0	Medium
Cola drinks	2.5	0.7	Medium

TABLE 2

Titratable Acidity of Foods

Foods	pH	Titratable acidity (g/100ml or g/100mg)
Water	7.28	0.02
Whole milk	6.69	0.10
Strawberry-flavored milk	6.41	0.12
Pears	5.72	0.12
Apples	5.47	0.17
Bananas	5.15	0.44
Natural cheese	5.01	0.50
Apple juice	3.58	0.58
Strawberry yogurt	4.10	1.27
Orange squash	2.82	2.27
Dried apricots	3.87	2.49
Seedless raisins	3.98	2.59

Another dietary habit of concern is a diet requiring lots of chewing. A diet of coarse, textured foods, such as nuts and raw vegetables, could lead to erosion or attrition of teeth due to the masticatory stresses. Recent work on human mastication underscores the importance of two mechanical properties: toughness and elastic modulus (stiffness). The toughness and stiffness of a food dictate the force necessary for the muscles of mastication to properly chew food. The force generated during routine mastication of foods varies from about 70-150 Newtons. Foods like carrots or meat require biting forces in the range of 70-150 Newtons while fruits generally require less than 20 Newtons. The maximum biting force is around 500-700 Newtons[19] (TABLE 3). Dietary tendencies to consume significant amounts of tougher cuts of meat, nuts, dried fruit, or raw vegetables would influence erosion of the teeth and ultimately the structural integrity.

Mastication of an unrefined diet increases the potential erosion of the dentition. An increase in the hardness of foods leads to an increase in the number of chewing strokes and chewing time[20,17] (TABLE 4). Non-Western dietary habits such as chewing on betel nuts (common in some Asian cultures) and eating chikki (nut brittle from India) may result in occlusal abrasive changes of the dentition resulting in reduced structural integrity. Habitual intake of snacks such as corn nuts, jaw breakers, and even pretzels could impact dental structural integrity. Although not a dietary substance, chewing tobacco with its acidity and coarse granules would also be erosive.

Ganss observed that individuals subsisting on a raw food diet, which was both fibrous and high in acid, developed marked occlusal wear with cupping of the exposed dentin.[21,22] Further progression of occlusal erosion leads to a distinct grooving of the cusps.[17] Both clinical and experimental observations indicate that individual wear mechanisms rarely act alone but interact together. A person with hypoplastic or hypocalcified defects as a result of poor nutrition has a "softening" of the teeth that compounds the effects of a future erosive diet (FIGURE 3). Additional signs of erosion are discoloration visible as a slight yellow appearance on the tooth surface and transparency of the anterior teeth along the incisal edges. Rounding of the teeth and/or cracks or roughness along the edges are also indicative of erosion.

The complex interactions of chemical, physical, and behavioral factors make it difficult to produce simple nutritional guidelines for decreasing the risk of erosive tooth wear, but addressing the dietary habits of the patient is important to eliminate one of the many factors that might affect dental structural integrity.

TABLE 3

Toughness of Foods (16L)

Food	Toughness (Jm -2)
Apple pulp	56.97
Raisin	306.60
Almond	308.62
Carrot	343.93
Prune	345.67
Pear skin	457.49
Dried apricot	565.24
Apple skin	662.89
Gummy bear	887.96

TABLE 4

Elastic Modulus (Stiffness) of Food (16L)

Food	Elastic Modulus (MPa)
Gummy bear	0.07
Raisin	0.22
Prune	0.47
Dried apricot	0.99
Apple pulp	3.41
Pear skin	5.80
Carrot	6.86
Apple skin	12.89
Almond	19.42

FIGURE 3. Erosive wear of tooth. Copyright of Minnesota Dental Association. Reprinted with permission

Understanding and Appreciating Ethnic Nutritional Patterns

Recent statistical analysis by the State of California Department of Finance suggests that California is experiencing unprecedented changes in the ethnic composition of the population.[23] The analysis reviewed data from years 2000-2008 and found that while California gained 4 million people, there were many different directions for the rate at which individual ethnicities were increasing and decreasing. Hispanic, Asian, Pacific Islander, and multiethnic populations increased their shares of the state's population by the greatest numbers relatively. In this same time period, whites decreased their percentage of the overall population of California to 40.8 percent from 47.2 percent pointing toward a 59.2 percent non-white population in California.[23] This study shows that more oral health care providers will be making recommendations to people who may not have a traditional American diet.

While it may not be possible to predict if these changes in the population will continue, it is important that oral health care providers adapt their understanding of nutrition to the changing population and their cultural diets. In an effort to guide families in obtaining a healthy diet, the U.S. Department of Agriculture has produced the MyPyramid Food Guidance System.[23] MyPyramid includes print materials and interactive online tools. The online tools allow consumers to learn more about the areas they are interested in, evaluate specific foods, and customize recommendations based on their height, weight, age, and activity level. There are versions for preschoolers, children, and pregnant and breastfeeding women to help them meet their unique nutritional needs.

This tool is based on a typical American diet; but in a state with such an ethnically diverse population, MyPyramid will not be appropriate for many patients who have not acculturated to a typical American diet. There is a Spanish version of MyPyramid that includes typical Latin American foods.[25] Fortunately, other groups, such as the Oldways Preservation Trust, have developed food pyramids specific to cultural groups or to vegetarians. Specific links are provided in the "Helpful Websites" section (**BOX 1**). These guides are a valuable source of information for California clinicians to educate themselves and their patients.

The guides that include lists of fruits and vegetables common to the specific populations (such as the Oldways Latin American and Asian Diet pyramids) can be especially useful for identifying possible sources of acidic snacks or tough foods that require extensive chewing. For example, the use of lemon and lime juice in salsa, ceviche, and menudo, which are common in Latin American cultures, could contribute to erosion. In the Filipino culture, any of the adobo dishes stew meats in vinegar. In the Vietnamese culture, there is a fish sauce called nuoc mam that has rice vinegar as one of its main ingredients. The Indian culture has a tamarind sauce that is quite acidic. Pickled radish and ginger are prevalent in the Japanese cuisine. Items in the Chinese diet such as dried preserved plum seeds, hot and sour soup, and lemon chicken are items that have an acidic component.

With improved understanding and appropriate education tools, oral health care providers will be able to make recommendations in a way that will help families reduce the likelihood of future dental erosion.

Mechanics for Nutrient Analysis

To assess the adequacy of a patient's diet, it is common to request a three-day food record with details about the amounts and types of food eaten. This data can be analyzed with tools available from the U.S. Department of Agriculture or with nutrient analysis software. The calorie intake can be compared to the dietary reference intake calcula-

BOX 1

Helpful Websites

www.mypyramid.gov
USDA Food Guide Pyramid in English and Spanish
Includes versions for pregnancy & breastfeeding, children 6-11 years old and preschoolers 2-5 years old

http://www.oldwayspt.org/asian-diet-pyramid
Asian Diet Pyramid from Oldways Preservation Trust

http://www.oldwayspt.org/latino-diet-pyramid
Latin American Diet Pyramid from Oldw ays Preservation Trust

http://www.oldwayspt.org/mediterranean-diet-pyramid
Mediterranean Diet Pyramid from Oldways Preservation Trust

http://www.oldwayspt.org/vegetarian-diet-pyramid
Vegetarian Diet Pyramid from Oldways Preservation Trust

http://www.dietitians.ca/news/downloads/Vegetarian_Food_Guide_for_NA.pdf
Vegetarian Food Guide for North Americans from Canadian/American Dietetic Associations

tion for energy to determine adequacy for growth. The intake of vitamins and minerals are compared to the dietary reference intakes (DRIs). While the old recommended dietary allowances (RDAs) were aimed at preventing deficiency, the current DRIs also aim to decrease the risk of chronic disease.[26]

This type of analysis is beyond the scope of dental visits, but a simple 24-hour recall of "usual intake" is a more practical tool. The patient is asked about usual or typical intake of foods and beverages at snacks and meal times. A targeted questionnaire could also be used.[27] This will help the oral health care provider identify areas for preventing further dental problems by providing dietary counseling, as discussed further below.

However, if this process identifies serious concerns about nutrient intake, or if more detailed counseling is necessary, then referral to a registered dietitian is recommended. Depending on the patient's insurance coverage, the patient may need a referral from a pediatrician or the primary care provider. The "Find a Registered Dietitian" button on the American Dietetic Association website (www.eatright.org) is useful to locate a local registered dietitian.

Nutritional Counseling

Oral health care providers can provide basic nutrition advice to patients to help prevent dental erosion. When making dietary recommendations, it is also important to factor in the cultural background of the patient. The following scenarios demonstrate how clinicians can counsel patients in a culturally sensitive manner to improve nutrient intakes.

Scenario 1

An Asian-American father brings his 5-year-old son for in evaluation. Clinical examination reveals some hypoplastic teeth that raise concern about the patient's calcium and vitamin D intake. When asked about his son's intake of milk, leafy greens, and tofu, the father reports that cow's milk is not offered at home. The son reports that he drinks some milk at school but then his stomach "doesn't feel good." The son has orange juice for breakfast and with his after-school snack.

Response: Explain how calcium intake is related to tooth development and how many people lose the ability to digest lactose as they age.[28] Suggest fortified soy milk, fortified orange juice, tofu, legumes, and nuts as foods that can help increase their calcium intake but do not contain lactose. Father and son agree they could drink fortified soy milk with dinner and they will include fortified soy milk in the son's lunch. The son likes nuts for snacks, so they will include this in his lunch box as well. Recommend changing to fortified orange juice, as this will increase calcium intake and cause less erosive tooth wear. The American Academy of Pediatrics recommends vitamin D supplementation (400 IU) for children who drink less than 1 L per day of vitamin D-fortified milk.[29-32]

Scenario 2

A first generation Chinese-American 15-year-old girl comes in for evaluation. Clinical examination reveals marked occlusal wear and white spot decalcification areas along the cementoenamel junction of numerous teeth. When asked about her schedule and eating habits, she reports she is taking several advanced-placement courses, plays basketball nearly year round, does track in the spring, and takes Chinese language courses on the weekend. She eats traditional Chinese foods at home and American foods and candies from the school cafeteria. She has sports drinks several days a week before, during, and after practices. She prefers to suck on lemon candies while she is studying.

Response: Explain the reason for concern about the patient's dietary habits. Her stress is leading to tooth grinding. These vulnerable teeth are suffering further damage due to her frequent exposure to sugars and acids via sports drinks and lemon candies. Encourage her to drink water before and after practice and limit sports drink use to practices and games lasting at least 90 minutes. Chocolate milk can be used as an alternative recovery drink. Recommend healthy snacks during study time, such as crackers and cheese, fruit, or sunflower seeds.

Scenario 3

A Mexican-American mother brings her 13-month-old boy in for evaluation. A clinical exam reveals an edentulous patient, and he appears small for age on gross exam. Past medical history indicates he was born at 26 weeks gestation and spent 10 weeks in the neonatal intensive care unit. The mother confirms that the pediatrician tells her the child has not yet reached the 5th percentile on the growth chart and the mother is concerned about her child's lack of teeth and asks for advice.

Response: Explain that premature infants may have slow tooth development, up to six months later than expected. Explain the importance of nutrition, especially adequate calcium and phosphorus intake, because he likely had inadequate mineral deposition due to his shortened gestational period. The mother reports that the boy used to drink premature discharge formula but she switched to cow's milk at his first birthday. Recommend to the mother that she continue with premature discharge formula for the higher calorie, vitamin, and mineral content.

Conclusion

Taking It Back to the Chair

Nutritional intake and dietary habits affect the structural integrity of the primary and permanent dentition. These habits have irreversible consequences for teeth, including compromised dental integrity and erosion.

Adequate nutrient intake and dietary counseling are essential components of preventive dentistry. The tide is turning, as more attention is being directed to these important factors.[27] Improved insurance reimbursement also helps increase the focus on these components. Careful evaluation of a patient's dietary history, coupled with the ability to implement targeted educational and motivational strategies relevant to the individual's ethnicity, will ensure success. Basic nutritional counseling at the dental practice and a timely referral to a registered dietitian are steps in a prudent direction to maintain dental structural integrity. It is time for the profession to give appropriate attention to the role of nutrition and dietary counseling in oral health. ■■■■

REFERENCES

1. McDonald RE, Avery DR, Dentistry for the Child and Adolescent, ninth ed., Mosby Elsevier, Mo., pages 41-3, 2010.
2. American Academy of Pediatric Dentistry, Nutrition and feeding systems: a dental health and development standpoint. Pediatric dental care: an update, pages 18-20, 1991.
3. American Academy of Pediatric Dentistry, Chronology and development of the dentition. *Pediatr Basics* 53:3-5, winter 1990.
4. Ferrini F, Marba S, Gaviao M, Oral conditions in very low and extremely low birth weight children *J Dent Children* 75(3):235-42, September-December 2008.
5. Seow WK, Brown J, et al, Dental defects in the deciduous dentition of premature infants with low birth weight and neonatal rickets. *Pediatr Dent* 6(2):88-92, 1984.
6. Slayton RL, Warren, JJ, Prevalence of enamel hypoplasia and isolated opacities in the primary dentition *Pediatr Dent* 23(1):32-6, 2001.
7. Seow WK, Humphrys C, Tudenhope DI, Increased prevalence of developmental dental defects in low birth-weight, prematurely born children: a controlled study. *Pediatr Dent* 9(3):221-4, 1987.
8. Jontell M, Linde A, Nutritional aspects on tooth formation *World Rev Nutr Diet* (48):114-36, 1986.
9. Kodali VR, The interface of nutrition and dentition *Indian J Pediatr* 65(4):529-39, 1998.
10. Dreizen S, The mouth as an indicator of internal nutritional

problems. *Pediatrician* 16:139-46, 1989.
11. Needleman HL, Allred E, et al, Antecedents and correlates of hypoplastic enamel defects of primary incisors. *Pediatr Dent* 14(3):158, 1992.
12. Bailey RL, Dodd KW, et al, Estimation of total usual calcium and vitamin D intakes in the United States. *J Nutr* 140:817-22, 2010.
13. Nikiforuk G, Posteruptive effects of nutrition on teeth. *J Dent Res* 49:1252-58, 1970.
14. Keels M, Tooth erosion in children, U.S. perspective. *Inside Dent* 5(3):3-18, 2009.
15. Zero DT, Etiology of dental erosion — extrinsic factors. *Eur J Oral Sci* 104:162-77, 1996.
16. Loewen RR, Marult RJ, Ruby JD, A review of the dental erosion literature and pH values for popular candies. *Northwest Dent* 87(2):1-11, 2008.
17. Magalhaes AC, Wiegand A, et al, Insights into preventive measures for dental erosion. *J App Oral Sci* (2):75-86, 2009.
18. Chuenarrom C, Benjakul P, Dental erosion protection by fermented shrimp paste in acidic food. *Caries Res* 44(1):20-3, 2010.
19. Williams SH, Wright B, et al, Mechanical properties of foods used in experimental studies of primate masticatory function. *Am J Primatol* 67:329-46, 2005.
20. Horio T, Kawamura Y, Effects of texture of food on chewing patterns in the human subject. *J Oral Rehabil* 16:177-83, 1989.
21. Ganss C, Schlechtriemen M, Klimek J, Dental erosions in subjects living on a raw food diet. *Caries Res* 33:74-80, 1999.
22. Lussi A, Jaggi T, Schurer S, The influence of different factors on in vitro enamel erosion. *Caries Res* 23:387-93, 1993.
23. State of California, Department of Finance, California county race/ethnic population estimates and components of change by year, July 1 2000-2008. Sacramento, Calif., June 2010.
24. U.S. Department of Agriculture. MyPyramid.gov. Accessed Jan. 26, 2011.
25. U.S. Department of Agriculture. mypyramid.gov/sp-index.html. Accessed Jan. 26, 2011.
26. Otten JJ, Hellwig JP, Meyers LD, eds, Dietary Reference Intakes: the essential guide to nutrient requirements. Institute of Medicine of the National Academies. The National Academies Press, Washington, D.C., 2006.
27. Mobley C, Dounis G, Evaluating dietary intake in dental practices: Doing it right, *J Am Dent Assoc* 141(10):1236-41, 2010.
28. Heymen MB for the committee on nutrition, lactose intolerance in infants, children, and adolescents. *Pediatrics* 188(3):1279-86, 2006.
29. Palmer CA, Butt G, Effective communication in dental practice, in Diet and Nutrition in Oral Health. Palmer CA, ed., Pearson Prentice Hall, Upper Saddle River, N.J., 2007.
30. Larsen MJ, Nyvad B, Enamel erosion by some soft drinks and orange juices relative to their pH, buttering effect and contents of calcium phosphate. *Caries Res* 33(1):81-7, 1998.
31. Lv N, Brown JL, Place of dairy products in the Chinese-American family food system. *J Am Diet Assoc* 110:1207-15, 2010.
32. Wagner CL, Greer FR, American Academy of Pediatrics section on breastfeeding and committee on nutrition, prevention of rickets and vitamin d deficiency in infants, children, and adolescents. *Pediatrics* 122:1142-52, 2008.

TO REQUEST A PRINTED COPY OF THIS ARTICLE, PLEASE CONTACT Randy Ligh, DDS, MA, 189 N. Bascom Ave., Suite 200, San Jose, Calif., 95128.

Even Better, Together.

Implant Direct
simply smarter.
Sybron Dental Specialties

Implant Direct Sybron International combines Sybron Dental Specialties' history of quality with Implant Direct's innovative future for unmatched service and value. That means a comprehensive line of implant solutions – industry-compatible implants and prosthetics plus regenerative materials and surgical instrumentation – for you to choose from.

Attachments | **Regenerative Materials** | **Implants** | **Abutments**

ScrewPlant®
ScrewPlus®

RePlant®
Industry-Compatible
Internal Tri-Lobe

SwishPlant™
Industry-Compatible
Internal Octagon

Legacy™
Industry-Compatible
Internal Hex

Innovation. Quality. Service. Value.

Find the **simply smarter** solution that fits your practice.

www.implantdirect.com | 888-649-6425

For Attachments International products, please call 800- 999-3003 or visit **www.attachments.com**

CDA JOURNAL, VOL 39, Nº4

Interaction of Dental Erosion and Bruxism: the Amplification of Tooth Wear

CRAIG A. PETTENGILL, DDS

ABSTRACT Bruxism and erosion are important to identify during a dental examination. By understanding the etiologies of both processes, a management strategy can be implemented to decrease their effects. Management for bruxism, clenching, and parafunction can include medications, cognitive behavioral therapy, and dental appliances. Bruxism, clenching, and parafunction combined with dental erosion can cause dental wear to increase faster than any component alone.

AUTHOR

Craig A. Pettengill, DDS, is in private practice in San Jose.

Bruxism is one of the main parafunctional habits that result in dental wear. When the tooth structure has been or is exposed to elements of dental erosion, the damaging result of bruxism is amplified due to the softening of the tooth structure. These two pathologic processes work synergistically. Other articles in this issue discuss the pathological basis for dental erosion and its prevention. In this article, the focus will be on secondary destructive processes that occur when it acts on tooth structures previously or is simultaneously weakened by dental erosion. These processes include bruxism, clenching, and parafunction (BCP).[1]

Bruxism is divided into diurnal and nocturnal, usually described with clenching and further categorized as parafunction.[2,3] Bruxism is discussed in the medical literature as a rhythmic masticatory movement disorder or rhythmic masticatory movement activity (RMMD/RMMA).[4,5] Given all of these unusual names for similar but not necessarily the same behavior, adds to the difficultly for providers, patients, and the public to understand such occurrences. Bruxism by definition is nocturnal or diurnal parafunctional activity including clenching, bracing, gnashing, and grinding of the teeth in the absence of subjective awareness. Nocturnal bruxism (sleep bruxism) is considered a central nervous system disorder and is associated with microarousals during sleep.[6] Diurnal bruxism (while the patient is awake) is primarily characterized by clenching or tapping of the teeth. Parafunctional habits can occur during the day as well, such as jaw bracing with or without tooth contact.[7]

Clenching is a nonfunctional, intermittent application of masticatory force, primarily from the elevator muscles, in a static occlusal relationship, may be diurnal or nocturnal, and the patient may not be aware of the muscle activity.

Parafunction includes all of the above and is another name for RMMD/RMMA. It is all nonfunctional jaw activity in the orofacial region, including clenching, bruxing, nail biting, lip and/or cheek chewing, etc.

Visual evidence of tooth wear has historically been the gold standard for the diagnosis of BCP. Tooth wear is a manifestation and loss of tooth structure due to noncarious processes such as attrition, erosion, and abrasion.[8] Damage from attrition are due to tooth-tooth contact. This can be seen with BCP. Though dental wear from mastication of food is possible, this is seldom the case with a Western diet. Erosion is multifactorial that can be based in dietary exposure or physiological imbalance (i.e., gastroesphageal reflex disorder also know as GERD). Lastly, tooth wear due to abrasion are due to excessive toothbrushing resulting in damage in the cervical portion of the teeth. These abrasive damages may occur either on the buccal or lingual surfaces. Of these etiologic processes, dental erosion is the most important because erosion weakens or softens the structural integrity of the tooth. This weakened state permits accelerated damage, either prior or simultaneously with other events. This is especially true when dental erosion occurs with BCP.

The exact prevalence of tooth wear is not clear, primarily due to different assessment criteria or definitions of the condition but it has been reported to range from 13 percent to 98 percent.[9,10] Tooth wear is considered to be an age-related process and as discussed above, it has a multifactorial etiology that includes the presence of parafunctional habits, occlusal characteristics, diet, salivary function, and composition.[11]

BCPs are important in the processes of tooth wear and tooth wear can provide some information about a history of forceful tooth-to-tooth contact. Tooth wear does not indicate current bruxism and it does not differentiate between clenching activity or parafunctional habits. The process of tooth wear has a multifactorial etiology that includes tooth erosion and BCP. Tooth erosion had a combination of factors that initiate and perpetuate erosion. Additionally, just as erosion has multifactorial etiologies, BCP has multifactorial etiologies as well. Systemic factors, medications, and localized factors need to be considered in analyzing BCP etiology. BCPs also have perpetuating factors and so it is difficult to describe the effects of both processes based on only one component etiology to our patients. Therefore, in each case, more than one etiology may be at work in BCP and erosion.

TABLE 1

Clinical Signs of BCP Commonly Found

Tooth wear (FIGURES 3A AND 3B)
Masseteric muscle hypertrophy
TMJ pain or muscle pain
Thermal tooth sensitivity to hot and/or cold testing
Tooth pain with biting
Tongue scalloping (FIGURE 2)
Cheek biting
Fractured restorations, fractured teeth, chipped teeth
Tooth mobility
Periodontal bone loss
Reactive lesions such as tori and buccal buttressing
Wear facets (FIGURE 4)
Reduced jaw mobility
Burning tongue

TABLE 2

Health Conditions Increasing the Risk for BCP

Systemic conditions Cerebral palsy Torticollis
High blood pressure
Diabetes
GERD
Obstructive sleep apnea
Depression/anxiety

Etiology of BCP

The etiology of BCP is multifactorial. One-sided implications for defining the etiology can be misleading and may be easier for patients to understand. However, treatment based on one component etiology may not yield the desired result. Several etiological theories have been studied and implicated in their role of BCP.

To start, defining diurnal versus nocturnal BCP may be of some significance. Most studies have been studying nocturnal BCP since it's easier to study while the patient is asleep.[12] Furthermore, there is a difference in brain activity in nocturnal BCP versus diurnal BCP. Nocturnal BCP has a complicated central nervous system (CNS) cascade of events leading to BCP intertwined with coexisting etiologies. Daytime BCP is likely to be the result of emotional tension or psychosocial disorders that force the subject to respond with a prolonged contraction of masticatory muscles or other jaw parafunction.[12]

Genetics and Heredity

Many clinicians have the impression that BCPs run in families and genetic effects may have a significant role in the origin of bruxism.[13] However, environmental factors may also have an effect as studies on members of the same family have differing results. This leads to diverse opinions regarding the relationship of genetic factors and BCPs. How-

TABLE 3

Medications Increasing the Risk for BCP

SSRIs Prozac Effexor
Amphetamines Ritalin Provigil Nuvigil Aterol
Alcohol
Caffeine
Tobacco
Street Drugs Methamphetamines Cocaine

TABLE 4

Combined Risk Factors

OSA
Loud snoring
Snoring, but less loud
Moderate daytime sleepiness
Alcohol use (1-2 drinks/day)
Heavy alcohol use (greater than 3 drinks/day)
Caffeine
Smoker
High stress
Anxiety

ever, in explaining to patients, it would be safe to say that between 21 percent and 50 percent of patients who develop sleep bruxism have a direct relative who also suffers from the same condition.[14]

Systemic Health

A review of the patient's health history is important in identifying systemic health conditions as etiologic risks for BCP (**TABLE 1**). Diseases of neurologic and psychiatric origin have been linked to the etiology of bruxism including brain damage from trauma, cerebral palsy, basal ganglia infarction, Down syndrome, epilepsy, Huntington's disease, Parkinson's disease, post-traumatic stress disorder, and Rett syndrome.[14] These systemic causes related to health conditions, such as cerebral palsy and sleep apnea, and other sleep disorders, can cause an increase of already existing BCP to occur.

Medications

Complicating systemic diseases and other health problems are the medications and combinations of medications that the patient may be taking. A list of a patient's current prescription medications should be reviewed in screening patients for BCP (**TABLE 2**). Some prescription medications are known to cause RMMA in patients such as the serotonin-specific uptake inhibitors (SSRIs) used for depression.[15] As with prescription medications, BCPs can be seen with substance abuse including alcohol, tobacco, high doses of caffeine, cocaine, amphetamines, ecstasy, and other recreational drugs.[7] (**TABLE 3**)

Obstructive Sleep Apnea and Sleep-Related Factors

Obstructive sleep apnea (OSA) could be considered a systemic cause of BCP and also could be considered to have a multifactorial etiology; however, it deserves a category of its own since there have been several articles in the recent literature that point toward OSA as a major etiologic factor in BCP.[16] Sleep bruxism has been shown to be part of complex arousal responses of the central nervous system occurring during changes in sleep stages.[17] OSA causes sleep arousals and sleep-related responses cause BCP.[18]

Several polysomnographic studies (PSG) have shown that BCP occurs during the lighter stages of sleep arousals, especially between stage 1 and stage 2.[18-20] BCPs can also occur during rapid-eye movement (REM) sleep.[21] Sleep disorders such as OSA cause sleep arousals, which in turn cause BCPs.

Patients with sleep arousals associated with restless leg syndrome and periodic limb movements also have an increase of BCP over the normal population. OSA patients with movement disorders show a full remission of BCPs when their OSA is treated.[14]

OSA patients are also reported to have a high incidence of systemic arterial hypertension, erectile dysfunction, muscular tension, palpations, and GERD.[5] GERD, as discussed in this journal, has a direct effect on dental erosion (**TABLE 2**).

Dental Occlusion

Dental occlusion and orofacial malrelationship and malpositioned tooth surface contacts have been considered to be the cause of BCP, especially the difference between centric relation and maximum intercuspation.[22] This concept has been extensively studied and even though occlusal schemes are relevant for the distribution of forces that go with bruxism activities, there is, at this time, no proof for a role of occlusion and articulation in the etiology of bruxism.[1]

Lifestyle and Stress

Stress and anxiety are contributing factors in BCP and the prevalence of teeth grinding is higher in adult patients who live under emotional tension.[23]

The clinical manifestation of stress and how it relates to BCP may be unclear; there may be several weeks without any clinical manifestation followed by bursts of activity coupled with psychological stress.[4] Although it is difficult to screen for stress, once a patient knowingly has recognized stress as a component, it may help in identifying exacerbations and remissions of BCP.[12]

In summary, it is therefore important to screen for all risk factors for BCPs by reviewing for the use of all prescription medications, recreational drugs, systemic diseases, hereditary factors, stress and

lifestyle conditions, and other possible circumstances in order to establish an etiological diagnosis of BCP, looking mostly toward multiple etiological factors.

Diagnosis of Bruxism/Clenching/Parafunction

The clinical basis for the diagnosis for BCP is mainly from subjective reports and, in some cases, objective evaluation can be used to diagnose BCP. Patient symptoms and/or clinical signs are of use in determining BCP.

Reported Symptoms of BCP

The patient-reported symptoms can be useful in alerting the clinician to possible problems associated with BCP. Though these reported symptoms are useful to initiate further evaluation, it should not be used as the basis for diagnosing BCP. Commonly reported symptoms may include:

- Patient may report tooth grinding
- Masticatory muscle weakness (jaw discomfort, jaw fatigue or pain, or muscle pain upon awakening in the morning
- Occasional headaches
- Thermal tooth sensitivity
- Tooth pain
- Damage to teeth, tooth chipping, restorations fracturing, fractured cusp, incidences of cracked tooth syndrome
- Cheek biting
- Drifting of teeth
- Masticatory muscle weakness (jaw discomfort, jaw fatigue or pain, or muscle pain upon awakening in the morning
- Tooth mobility
- Periodontal bone loss in some cases

DENTAL EXAMINATION

Evidence of tooth wear or wear facets has always been the gold standard for the diagnosis of BCP. A complete dental exam with mounted diagnostic models and photos are often useful in visualizing signs of dental wear. When signs of dental wear are present, the clinician must appreciate that this may be either signs of wear from past pathosis or it may be indicative of present problems. The ideal situation is to have a series of mounted models over a period of time so the rate of tooth wear can be documented. The problem with this approach is that tooth wear occurs at such a slow rate that it is not feasible to maintain the necessary collection of models in clinical practice. A series of clinical photographs may be a more viable option for documenting tooth wear.

Though the initial set of study models will help greatly in identifying areas of present and past dental wear, the clinical exam is useful in identifying areas that require future photo documentation. During the exam process, it is important not only to analyze centric positioning to identify wear due to clenching, lateral, and protrusive movements may help the clinician appreciate the excursive movements associated with bruxism (**FIGURE 1**).

Additionally, the wear patterns of a daytime BCP patient may be quite different from a nocturnal BCP patient. Daytime BCP patients tend to clench, with possible minimally excursive bruxism. The resulting defect is a deeper wear between the cusp tips, similar to a mortar and pestle effect. Nocturnal BCP patients tend to have a wider range of excursive movements and the occlusal examination of excursive movements may help identify and provide an understanding of different tooth wear patterns.

These analyses are important because it documents the tooth wear and provides a tool for patient education. Some BCP patients are unaware of their parafunctional habits and need visual documentation to

FIGURE 1. Accessing tooth wear during lateral movements of the jaw.

FIGURE 2. Tongue scalloping.

FIGURE 3A.

FIGURE 3B.

FIGURES 3A AND 3B. Tooth wear.

FIGURE 4. Wear facets.

FIGURE 5. Evidence of wear on a portion of the patient's appliance. Wear shows on this appliance as rough, nonpolished areas.

appreciate their problem, cooperate with treatment plan development, and be a willing participant in the treatment process.

Other combined risk factors that may be suggestive of BCP are included in **TABLE 4**.[7] Though one factor is not enough to make a diagnosis of BCP, several of these symptoms and clinical signs help confirm a tentative working diagnosis of BCP. Making the patient aware of these will further reinforce the patient's appreciation of their problem.

Definitive Diagnosis of BCP

In the clinical practice, many of us often see these clinical signs. Our management strategy is similar to a "blind" elimination approach. This is where treatment/management approaches are applied and the hope to see resolution of the problem. A standard example of this in clinical practice is the management of putative oral lesions associated with candidasis. This shotgun approach should be questioned because the damaging effect progresses slowly so it is not clear if one is on the correct path toward resolution. The only effective way to manage these problems is to definitively diagnose BCP.

Though there are many clinical signs suggestive of BCP, the definitive confirmation of BCP requires advanced-diagnostic evaluation. There are at the current time, three possible ways to evaluate for BCP. Removable appliance therapy (splints/nightguards) will show areas of wear on the surface of appliances worn by these patients at night (**FIGURE 5**). Portable electromyographic (EMG) devices have been developed that the patient can take home to record nocturnal episodes of increased jaw closing muscle activity and hence BCPs. With these devices, muscle activity can be measured with an EMG recording of the masseter or temporalis muscles during the night. The third confirmation of BCPs is a sleep study whereby a polysomnogram (PSG), either in a sleep laboratory or an ambulatory home test, is performed. Although more sophisticated than simple EMG monitoring, a PSG also uses an electrode on the temporalis or masseter muscle and an increase in EMG levels over baseline indicate BCP activity. This testing has the greatest reliability in diagnosing BCP; however, most clinicians without appropriate training would generally not have this as a part of their clinical protocol. For that reason, confirmations will generally require the referral to medical or dental practitioners familiar with dental sleep disorders.

Management

Defining treatment goals for long-term retention of teeth and tooth structure is the most important part of managing these patients. The management of BCP and its potential effects on tooth wear are to initially educate the patient. Medical and dental treatment with any or all of the following could be considered: medication management, cognitive behavioral therapy, such as biofeedback, appliance therapy (such as a splint or nightguard), and occlusal adjustment to localized areas in order to alter adverse local force loading.

Medication management can be considered initially to get sleep bruxism under control while other therapy is being instituted. Muscle relaxants work systemically to reduce the severity and duration of BCP during the night.[25] There are few studies on the use of medications for bruxism alone. Most of the studies are combined with patients with muscle pain related to Botox products and can be considered in extreme cases in order to begin the process of managing night BCP but will manage daytime BCP as well.[26-28] Botox decreases masseter and temporalis muscle activity thereby decreasing the effects of BCP. The risk factor to benefit ratio should be considered with these medications as well as the health of the patient being treated.

Cognitive behavioral therapy includes comprehensive stress management, counseling programs that involve a combination of EMG biofeedback, progressive relaxation, and self-directed changes in lifestyle. These therapies appear to be more effective when used together than any single, behavioral treatment use alone.[29,30] Biofeedback is defined as the voluntarily changing physical activity using equipment that gives a visual or auditory signal of the activity or function. The patient can recognize and appropriately react to this signal thereby changing behavior. Biofeedback has been shown to be effective in reducing daytime and nighttime parafunction in several studies.[31] Biofeedback without a more comprehensive stress management program appears to decrease bruxism only temporarily, therefore, its use may be limited to short-term management of acute conditions.[32] Combined with other therapy, it can help manage the potential effects of BCP in the overall treatment of these patients.

Removable appliances (also called nightguards, splints, etc.) are available in a variety of different materials and can be a maxillary appliance, mandibular appliance, or utilized together. There is no one treatment to treat bruxism and therefore reasoning should be turned to removable appliances to cover the teeth, protecting them from the harmful effects of long-term BCP. If there is enough free way space and the appliances can be tolerated by the patient, two appliances can splint teeth for periodontal purposes and allow freedom of movement for optimal support.

Limited occlusal adjustment to equalize tooth contacts evenly around the dental arches and allow the freedom of cusp tips to move into excursive movements freely, without the interference of opposing teeth, can be considered. Premature occlusal contacts are thought by some dentists to have been a perpetuating factor in BCP for some patients and advocates for occlusal adjustment recommended limited occlusal adjustment. Limited occlusal adjustments are treatment planned to evenly distribute tooth contacts for teeth that have mobility and to decrease tooth mobility due to stronger tooth contacts in adjacent teeth. Thus, this decreases the potential for early tooth loss due to heavy occlusal trauma causing decreased amounts of periodontal attachment.[33]

Conclusion

Erosion is not the result of just one cause. Several factors interact and are implicated in tooth wear etiology. Systemic factors along with localized factors are taken into account and when discussing BCP. An overall review of a patient's health history and current prescription medications are important in identifying risks for BCP. The multifactorial link between reasons for tooth wear, patient health status, and medications all play a role in erosion.

Therefore, bruxism, clenching, and parafunction have etiologic perpetuating risk factors, and, combined with primary tooth erosion risk factors, may have significantly increased effects that are difficult to describe based on one component etiology. A large study needs to be designed and confounding factors integrated to be possible to reproduce research into clinical practice settings. BCP can work synergistically with dental erosion to result in an accelerated dental wear. Thus, it is critical to recognize both of these etiologic processes early and implement preventive measures. ■■■■

REFERENCES

1. De Leeuw R, Orofacial pain. Guidelines for assessment, diagnosis, and management, fourth edition, Chicago: *Quintessence*, 2008.
2. Ohayon MM, Li KK, Guilleminault C, Risk factors for sleep bruxism in the general population. *Chest* 119:53-61, 2001.
3. Gold AR, Dipalo F, et al, The symptoms and signs of upper airway resistance syndrome: a link to the functional somatic syndromes. *Chest* 123:87-95, 2003.
4. Lavigne GJ, Rompre PH, et al, Rhythmic masticatory muscle activity during sleep in humans. *J Dent Res* 80:443-8, 2001.
5. Aloe F, Sleep bruxism neurobiology. *Sleep Science* 2:40-8, 2009.
6. American Academy of Sleep Medicine. International classification of sleep disorders, second edition, Westchester, Ill., American Academy of Sleep Medicine, 2005.
7. Lavigne GJ, Cistulli PA, Smith MR, Sleep medicine for dentists. a practical overview. Chicago, *Quintessence*, 2009.
8. Litonja L, Andreana S, et al, Tooth wear: attrition, erosion and abrasion. *Quintessence Int* 34;435-46, 2003.
9. Kelleher M, Bishoo K, Tooth surface loss: an overview. *Br Dent J* 186:61-6, 1999.
10. Hugoson A, Bergendal T, et al, Prevalence and severity of incisal and occlusal tooth wear in an adult Swedish population. *Acta Odontol Scand* 46:255-65, 1988.
11. Seligman DA, Pullinger AG, The degree to which dental attrition in modern society is a function or age and canine contact. *J Orofac Pain* 9:266-75, 1995.
12. Glaros A, Incidence of diurnal and nocturnal bruxism. *J Prosthet Dent* 45:545-9, 1981.
13. Reding GR, Rubright WC, Zimmerman SO, Incidence of bruxism. *J Dent Res* 45:1198-204, 1966.
14. Paesani D, ed., Bruxism: theory and practice. United Kingdom, Quintessence Publishing, 2010.
15. Leo R, Movement disorders associated with the serotonin selective reuptake inhibitors. *J Clin Psychiatry* 57:449-54, 1996.
16. Okeson J, et al, Nocturnal bruxing events in subjects with sleep-disordered breathing and control subjects. *J Craniomandib Disord Facial Oral Pain* 5:258, 1991.
17. Lobbezoo F, Naeije M, Bruxism is mainly regulated centrally, not peripherally. *J Oral Rehab* 28:1085-91, 2001.
18. Macaluso GM, Guerra P, et al, Sleep bruxism is a disorder related to periodic arousals during sleep. *J Dent Res* 77:565-73, 1998.
19. Kato T, Rompré P, et al, Sleep bruxism: an oromotor activity secondary to micro-arousal. *J Dent Res* 80:1940-4, 2001.
20. Kato T, Montplaisir JY, et al, Evidence that experimentally induced sleep bruxism is a consequence of transient arousals. *J Dent Res* 1940-4, 2003.
21. Bader GG, Kampe T, Descriptive physiologic data on a sleep bruxism population. *Sleep* 20:982-90, 1997.
22. Ramfjord SP, Bruxism, a clinical and electromyographic study. *J Am Dent Assoc* 62:21-44, 1961.
23. Kampe T, et al, Personality traits in a group of subjects with a longstanding bruxism behavior. *J Oral Rehabil* 26:455, 1997.
24. Lavigne GJ, Guitard F, et al, Variability in sleep bruxism over time. *J Sleep Res* 10:237-44, 2001.
25. Saletu A, Parapatics S, et al, On the pharmacotherapy of sleep bruxism: placebo-controlled polysomnographic and psychometric studies with clonazepam. *Neuropsychobiol* 51:214-25, 2005.
26. Tan E, Jankovic J, Treating severe bruxism with botulinum toxin. *J Am Dent Assoc* 131(2)211-16, 2000.
27. Nixdorf D, Heo G, Major P, Randomized controlled trial of botulinum toxin A for chronic myogenous orofacial pain. *Pain* 99(3):465-73, 2002.
28. Freund B, Schwartz J, Symington M, Botulinum toxin: new treatment for temporomandibular disorders. *Br J Oral Maxillofac Surg* 38:466-71, 1999.
29. Funch DP, Gale EN, Factors associated with nocturnal bruxism and its treatment. *J Behav Med* 3:385-97, 1980.
30. Pierce CJ, Gale EN, A comparison of different treatments for nocturnal bruxism. *J Dent Res* 67:597-601, 1988.
31. Solberg WK, Rugh JD, The use of biofeedback devices in the treatment of bruxism. *J South Calif Dent Assoc* 40:852-3, 1972.
32. Lobbezoo F, van der Zaag J, et al, Principles for the management of bruxism. *J Oral Rehabil* 35:509-23, 2008.
33. Philstrom B, Anderson KA, et al, Association between signs of trauma from occlusion and periodontitis. *J Periodontol* 57:1-6, 1986.

TO REQUEST A PRINTED COPY OF THIS ARTICLE, PLEASE CONTACT Craig Pettengill, DDS, 1660 Westwood Drive, San Jose, Calif., 95125.

AGD 2011 San DieGO!

Annual Meeting & Exhibits

July 28 to 31, 2011

Register Today!

Visit *www.agd.org/sandieGO* and click on "Register Now."

Get Ready for Cool Courses!

An entire year's worth of quality courses will be offered at the meeting and dentist registrants will receive access to up to 80 hours of recorded continuing education sessions—FREE with registration.

Get Set for Sun-sational Speakers and Participation Courses!

- Gordon J. Christensen, DDS, MSD, PhD ("The Christensen Bottom Line")
- David S. Hornbrook, DDS, FAACD ("Hot Topics in Restorative and Esthetic Dentistry")
- Pascal Magne, PhD, DrMedDent ("Biomimetic Restorative Dentistry")
- Harold L. Crossley, DDS, PhD ("What's the Real Deal About Street and Prescription Drug Abuse?" and "The 30 Most Physician-Prescribed Medications")
- Louis Malcmacher, DDS, MAGD ("Total Facial Esthetics for Every Dental Practice")

GO! to Hear from the Leading Scientist in Genomic Research!

The pioneer researcher who uncovered the sequence of the human genome, Dr. J. Craig Venter, is the 2011 AGD Keynote Speaker!

GO

Academy of General Dentistry™

THE SMILES THEY WANT. THE GROWTH YOU NEED.

Happy patients are key to growing your practice—and Invisalign® can help you get there.

Over one million patients have already chosen the Invisalign system for straighter teeth and a more beautiful smile, and the number is growing every day. Here's why:†

- 96% patient satisfaction
- Nine out of 10 Invisalign patients would recommend Invisalign to their friends and family
- #1 brand for all orthodontic patients

Isn't it time for you to become an Invisalign provider?

Become an Invisalign provider today.
Register for new provider training at
www.cdapresents.com

invisalign®
Science in Every Smile

† U.S. Service data 2009. Align Technology, Inc.

CDA JOURNAL, VOL 39, Nº4

Decision-Making in the Management of the Patient With Dental Erosion

DONALD A. CURTIS, DMD; JAY JAYANETTI, DDS; RAYMOND CHU, DDS; AND MICHAL STANINEC, DDS, PHD

ABSTRACT The clinical signs of dental erosion are initially subtle; yet they often progress because the patient remains asymptomatic, unaware, and uninformed. Erosion typically works synergistically with abrasion and attrition to cause loss of tooth structure, making diagnosis and management complex. The purpose of this article is to outline clinical examples of patients with dental erosion that highlight the strategy of early identification, patient education, and conservative restorative management.

AUTHORS

Donald A. Curtis DMD, is a professor, Department of Preventive and Restorative Dental Sciences, University of California, San Francisco, School of Dentistry.

Jay Jayanetti, DDS, is an assistant clinical professor, Health Sciences, Department of Preventive and Restorative Dental Sciences, University of California, San Francisco, School of Dentistry.

Raymond Chu, DDS, is in private practice in Cupertino, Calif.

Michal Stanine, DDS, PHD, is a clinical professor, Department of Preventive and Restorative Dental Sciences, University of California, San Francisco, School of Dentistry.

Dental erosion is defined as the pathologic chronic loss of dental hard tissues due to the chemical influence of exogenous or endogenous acids without bacterial involvement.[1-3] Like caries or periodontal disease, erosion has a multifactorial etiology and requires a thorough history and examination for diagnosis, and requires patient understanding and compliance for improved outcomes.[4,5] Erosion can affect the loss of tooth structure in isolation of other cofactors but most often works in synergy with abrasion and attrition in the loss of tooth structure.[5,6] (**TABLE 1**). Although erosion is thought to be an underlying etiology of dentin sensitivity, erosion and loss of tooth structure often occurs with few symptoms.

The purpose of this article is threefold: first, to outline existing barriers that may limit early management of dental erosion; second, review the clinical assessment required to establish a diagnosis of erosion; and third, outline clinical examples that review options to restore lost tooth structure. The authors have included illustrations they hope will be used to improve patient understanding and motivation in the early management of dental erosion.

Barriers to Early Management

Benign neglect may be the best way to describe historically the management of patients with dental erosion. The effects of erosion have traditionally been monitored until sufficient tooth structure was missing and then restorative intervention has occurred. Early management of patients with dental erosion has not occurred due to a patient's being unaware of everyday habits that

CDA JOURNAL, VOL 39, Nº4

TABLE 1

Common Reasons for Loss of Tooth Structure

Process	Definition	Affected area	Etiology
Erosion	Loss of tooth structure caused by acids other than those produced by bacterial plaque	Anywhere, but certain patterns are common	Dietary or gastric acids
Attrition	Loss of tooth structure caused by tooth-to-tooth contact	Tooth surfaces contacting in function, usually occlusal in the posterior, or any anterior surface depending on occlusion	Natural attrition of 35µ year; bruxism in extreme example
Abrasion	Loss of tooth structure caused by rubbing by an extrinsic object	Usually cervical, but could be anywhere	Extrinsic objects such as a toothbrush or abrasive food
Abfraction	Loss of tooth structure in the cervical area	Cervical area	Occlusal stress

contribute to erosion, dental professionals being unaware of the complex synergy between erosion and cofactors, and the general difficulty of patient compliance in chronic processes such as dental erosion.

Erosion as a prevalent and preventable process is often unappreciated by patients. Erosion is not in the mainstream of public understanding and the significance is often dismissed. Rarely does a patient present with a chief complaint of "dental erosion" while a chief concern of "having decay," "periodontal disease," "wear," "needing implants," or having "painful teeth" is much more common. Erosion is just not on the public radar. It is difficult to guide patients toward responsible management of the early stages of dental erosion because it is often asymptomatic, subtle, requires behavioral change, and has an etiology and progression the patient is unfamiliar with and many have doubts about. Seeing something visibly wrong such as decay from caries or mobility from periodontal disease is more compelling and motivating to a patient than the subtle generalized initial presentation of erosion. Hearing about erosion for the first time from a health care provider when they have not heard of the process and have few visual or symptomatic cues can result in skepticism.

A second reason diagnosis and management of early stages of dental erosion is often not occurring in dental practices is because the topic is often not emphasized in dental curricula and seldom part of continuing education programs. It is only recently we have understood the etiologic and complex interplay of cofactors responsible for erosion and resulting tooth structure loss. This unfortunate lack of professional education and development has resulted in limited understanding of strategies for early diagnosis and management of dental erosion.

A third reason early diagnosis and management of dental erosion has been lacking, despite recent publications citing dental erosion being a significant public health issue, is because of the lack of incentives to dentists for conservative management. Insurance companies provide little incentive when they explicitly state, "The effects of erosion and attrition are not covered benefits." This is a difficult policy to rationalize. While protocols such as CAMBRA and periodontal recall have allowed patients to maintain dentition longer, processes such as erosion and attrition have a significant accumulative effect on tooth structure loss. [4,7,8] Additionally, the health care industry, of which dentistry is a part, is a procedure-driven service. Clinicians are paid for procedures and not for conservative management, which decreases incentives toward uncompensated management of chronic processes such as dental erosion.

Assessment

A thorough clinical examination and history is important to determine which teeth from which sources have been impacted by erosion. A clinical diagnosis of erosion is based on surface characteristics of the teeth so a careful visual examination is critical. However, the etiologic factors that explain the clinical characteristics require an equally thorough history. It is important to review potential sources of endogenous and exogenous acids, as well as the presence of bruxism and tooth brushing habits as cofactors. Numerous variables contribute directly and indirectly to erosion including pH, buffering capacity, chelating potential of weak acids such as citric and acetic acids, and titratable acidity.[9,10] It is only after a thorough clinical examination and detailed history that restorative procedures should be planned.

Endogenous Acid

Endogenous factors that cause erosion are gastric acids that reach the oral cavity. This can occur with vomiting from an eating disorder or from gastroesophageal reflux disease (GERD). Endogenous gastric hydrochloric acid has a lower pH and a greater potential for rapid destruction of tooth structure than dietary exogenous sources of acid.

Eating disorders include anorexia nervosa and bulimia. Anorexia ner-

FIGURE 1. Dramatic example of a patient who presented with noncarious cervical lesions (NCCLs). Erosion can contribute to tooth structure loss seen with NCCLs.

vosa occurs with an incidence of 1 per 100,000, affects mostly white, upper-class females between the ages of 12 and 30 with a genetic component to the etiology based on twin studies.[11,12] Anorexia nervosa is an imbalanced and restrictive dietary intake with the extreme pursuit of thinness that results in less than 85 percent of normal body weight.

Bulimia occurs in a slightly older group than anorexics, is observed with a frequency of 1 to 3 percent of females, and typically involves binge eating and self-induced vomiting. The clinical appearance of dentition in a patient with an eating disorder is erosion of the palatal surfaces of the upper anterior teeth and often of the palatal aspect of the maxillary posterior teeth.[11,13]

GERD has been estimated to affect 7 percent of the population on a daily basis, 36 percent at least once a month, and 65 percent of the population at some point in their life.[14-16] Additionally, GERD can be asymptomatic in approximately 20 percent of patients.[17] Although the effects of GERD can result in different patterns of tooth structure loss; mandibular posterior teeth are most often affected.[16] However, often there are multiple sources of endogenous and exogenous acids that contribute to diverse patterns of tooth structure loss. Analysis has shown tooth structure loss in the primary dentition predicts tooth structure loss in the adult dentition so a history that includes primary dentition can be helpful.[18]

Exogenous Acid

Exogenous sources of erosion include the many dietary indulgences from our modern lifestyle including excessive soft drinks, sports drinks, power drinks, chewable vitamins, fruits, (especially if incised) excessive use of vinegar, alcohol including red and white wines, and certain herbal teas.[2] The frequency and duration of erosive acid contact are also important. For example, in a patient swirling an acidic drink in their mouth will result in greater potential harm than a patient using a straw.[19,20] There has been an increase in the consumption of acidic foods and drinks that are low in pH and/or have chelating effects on the enamel and dentin. Finally, there can be environmental sources of erosion that can range from industrial chemicals to the repeated contact of chlorine in pool water for swimmers. Enamel will start to demineralize below a pH of 5.2 and many drinks, foods and environmental exposures are below that threshold.[2] The presence of mineral supplements to drink and food can significantly decrease the erosive potential.

Synergistic Mechanisms

Erosion and Abrasion

Since dental erosion is a surface phenomenon, other surface processes like abrasion significantly amplify the impact of erosion. Erosion occurs when an acid solution with its free hydrogen ion diffuses through plaque, the acquired pellicle, and lipid coating of an enamel crystal to interact and demineralize enamel. In dentin, acid solution effects are more complex but involve a similar process. Dental erosion can occur from the free hydrogen ion in an acid (generally below pH 5.2) but also at higher pH (6-7) by acid ions such as the citrate ion of citric acid that can complex with the carbonate in enamel apatite. After an acidic exposure, enamel and dentin are superficially softened becoming more susceptible to cofactors like abrasion and attrition that can accelerate tooth structure loss. In enamel, the softened layer is about 5 microns.[21,22] Abrasion, primarily toothbrush abrasion, often works with erosion synergistically to affect loss of tooth structure. For example, it has been shown that abrasion from toothbrushing in the presence of a recent exposure to citric acid increased the rate of tooth structure loss by 50 percent.[6] Dentin is also vulnerable to toothbrush abrasion.[22,23]

A dental history should include a review of traditional sources of erosion as well as cofactors and behaviors that together with erosion result in loss of tooth structure. Often, it is a variety of different sources of acid and/or behaviors or habits that will collectively result in a loss of tooth structure. For example, a patient consuming six sports drinks (with citric acid) a day may compensate by immediately brushing after drinking. This would be unfortunate as the acid-softened enamel is vulnerable to abrasion and requires several hours for remineralization.[6,24] Asking the patient to wait two hours after an acidic exposure before brushing will result in less tooth structure loss.[6]

An example (**FIGURE 1**) shows an elderly patient with GERD who is on multiple medications and presents with noncarious cervical lesions (NCCLs). The medication-induced xerostomia results in decreased salivary lubrication, buffering capacity, and a pH that increases the risk for both attrition and erosion. The NCCLs, such as these, had been thought to be the result of occlusal forces, which cause stress concentration in the cervical area, while current literature supports the theory that NCCL is a result of erosion and toothbrush abrasion more than occlusal forces.[3,25-27]

FIGURE 2. Examples of various stages of erosive patterns on occlusal surfaces: healthy dentition, mild, moderate, and severe erosion on the occlusal and incisal surfaces of dentition.

Erosion and Attrition

Attrition is also a cofactor that with erosion can result in loss of tooth structure. Although the evidence for the synergy of erosion/attrition is not as strong as the evidence for erosion/abrasion, there is indirect evidence.[21,28] In bruxers, loss of tooth structure from attrition is more significant in the presence of erosion. The use of a nightguard appliance is indicated when a patient is suspected of grinding their teeth at night and has clinical signs of dental erosion. In extreme cases, loss of tooth structure and loss of occlusal vertical dimension can occur.[29]

Management of the Patient With Dental Erosion

Patient Education

Because of the unfamiliarity of erosion to the general public, graphic pictures illustrating the potential progression of erosion can be helpful (**FIGURE 2**). Visual cues are often more compelling than verbal descriptions. A second approach to counseling patients toward behavioral changes necessary in managing the early stages of dental erosion is the use of validated motivational techniques. Studies have shown that the technique of motivational interviewing can improve patient compliance.[30] Motivational interviewing theory has shown two factors most significant in affecting behavioral change and compliance in patients: First, guiding the patient to articulate the desired change, such as a reduction in the use of soft drinks; and second, the patient perceiving the clinician has genuine empathy and concern for them. Using pictures illustrating the progression of dental erosion and using techniques of motivational interviewing are likely to raise patient understanding and compliance in the management of early stages of dental erosion.

Restorative Considerations

As a surface phenomenon, conservative strategies that provide a barrier to exposure, minimize the time of exposure, or help neutralize and reverse the effects of acidic exposure are often helpful. This can include behavioral modifications such as decreasing the consumption of foods with erosive potential, modification of habits such as overzealous use of a toothbrush soon after an acid exposure or not swishing acidic fluids around in the mouth, biologic strategies such as remineralization to offset the surface effects of erosion or barrier considerations.

BARRIER CONSIDERATIONS

The acquired salivary pellicle is a potentially effective barrier to the effects of erosion. The use of abrasive toothpastes or tooth-whitening agents that can disrupt or remove the pellicle should be avoided. Use of trays over the dentition during acid exposure can provide a mechanical barrier and help protect the dentition. Use of a straw when a patient is drinking fluids with erosive potential can help lessen the impact on dentition.[20] In a bruxing patient with erosion that has potentially softened enamel, the use of a nightguard can decrease the potential for loss of tooth structure from attrition.

REMINERALIZATION STRATEGIES

Factors that increase salivary flow such as gum chewing will likely increase pH, buffering capacity, lubrication, and remineralization potential.[31,32] Gum chewing is especially useful as compliance is often better with gum chewing than other approaches. Use of fluoride in the form of toothpastes, gels, in combination with trays, may benefit remineralization, especially if other minerals such as calcium are available.[33]

MATERIALS SELECTION

Generally, early treatment of mild-to-moderate tooth structure loss from erosive patterns affecting occlusal, incisal, and facial surfaces are best with a composite resin material. The clinician needs to remember that the resin bond strengths to sclerotic dentin are lower than to normal dentin.[34] Therefore, any time surrounding beveled enamel is present the best bond is achieved. Roughening up the dentin with a steel bur has been shown to be better than a diamond bur.[35] Longevity of the restorations will depend on the bond to dentin, the wear characteristics of the material, and the loading on the material. The dentin bonding can be degraded by an acid challenge so trying to engage a beveled enamel border to the restoration is ideal.

It is often difficult to determine if the erosion process is active or not. One way is to use a round bur to mark a superficial

FIGURE 3A.

FIGURE 3B.

FIGURE 3. Examples of different patients with facial erosion. In **FIGURE 3B**, loss is seen of lingual tooth structure, resulting in incisal translucency. The arrow shows the rim of enamel at the gingival margin, showing the protective effects of saliva from the crevicular fluids.

scratch across an eroded surface that is out of occlusion and see if the added mark is still visible after a month. If it is visible, then the rate of tooth structure loss is slow. The other is to evaluate sequential study casts at one-year intervals.

In the following clinical examples, the authors outline strategies for management of the patient with dental erosion. Since the diagnosis of erosion is based on clinical appearance of tooth surface characteristics, different patient presentations are outlined. Materials selection in conservative management is discussed and clinical examples in complex, multidisciplinary treatment are reviewed.

In **FIGURE 2** are examples of various stages of erosive patterns on occlusal surfaces: healthy dentition, mild, moderate and severe erosion on the occlusal and incisal surfaces of dentition. In the initial stages of erosion (mild) there is rounding of cusps and grooves, pitting of noncontacting surfaces, and "raised restorations" where erosion has caused general loss of tooth structure around fillings. In these situations, conservative management including patient education and a determination of the etiology is critical followed by conservative etching and placement of composite restorations in the areas of erosive pitting. In the moderate erosion example, the erosion and attrition have resulted in the loss of additional tooth structure. The exposed dentin on tooth No. 15 would be best restored with a gold restoration to minimize tooth reduction. In the example of severe erosion, there has been an extreme loss of tooth structure and will likely require a multidisciplinary approach including crown lengthening and/or extractions. These pictures can be helpful in patient education to show the progression of erosion.

In **FIGURE 3A**, illustrations show examples of different patients with facial erosion. The diagnosis of erosion is a visual diagnosis of surface characteristics and these illustrations shows various presentations of tooth structure loss with erosion as one of the etiologic factors. The clinical appearance of erosion will often include the absence of facial anatomy and a smooth, glazed appearance. In more advanced examples of erosion, the dentin is exposed on the facial surface.

In **FIGURE 3B**, loss is seen of lingual tooth structure, resulting in incisal translucency. The arrow shows the rim of enamel at the gingival margin, showing the protective effects of saliva from the crevicular fluids.

Management of the Patient With Advanced Erosion

The following example is of a patient who presented with advanced erosion and with multiple cofactors that contributed to loss of tooth structure and required multidisciplinary treatment. (Treatment was completed by Jay Jayanetti, DDS.)

Patient presented with extensive loss of tooth structure (**FIGURE 4A**). By history and a clinical examination, the etiology of tooth structure loss was felt to be erosion with secondary factors of abrasion and attrition.

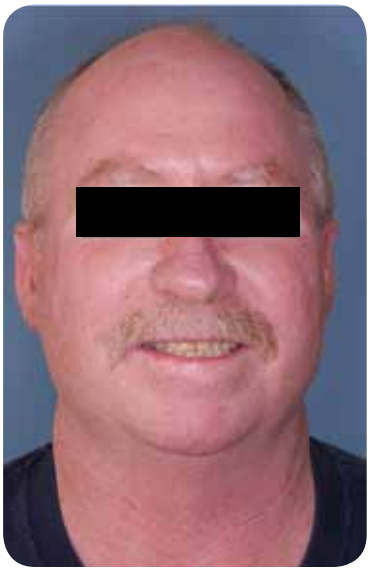


FIGURE 4A. Patient presented with extensive loss of tooth structure.

FIGURE 4B. Clinical exam revealed teeth with a glossy texture, smooth surfaces, flattening of defined anatomy and increased incisal translucency, all clinical findings consistent with a diagnosis of dental erosion.

The erosion was determined to be dietary, the abrasion related to toothbrushing and the attrition secondary to bruxing. The factors of a square angle jaw and having end-on occlusion were additional cofactors resulting in additional loss of tooth structure.

A clinical exam revealed teeth with a glossy texture, smooth surfaces, flattening of defined anatomy, and increased incisal translucency, all clinical findings consistent with a diagnosis of dental erosion (**FIGURE 4B**). The cervical tooth structure loss commonly diagnosed as abfraction was probably more a result of erosion with toothbrush abrasion.

An occlusal view of the anterior maxillary dentition showing the "cupped" incisal pattern, wear of nonoc-

FIGURE 4C. An occlusal view of the anterior maxillary dentition showing the "cupped" incisal pattern, wear of nonoccluding surfaces and "alloy islands" in posterior dentition, all consistent with dental erosion.

FIGURE 4D. Mandibular molars are often the most affected by GERD. Mandibular dentition shows many of the same patterns of tooth structure loss seen in the maxillary arch.

FIGURE 4E. Based on a diagnostic wax-up, an evaluation of retention and resistance form of remaining dentition, it was determined the occlusal vertical dimension should be increased.

FIGURE 4F. Following provisional restorations at the increased occlusal vertical dimension, it was determined the remaining tooth structure was inadequate for the required retention and resistance necessary for nonsplinted crowns, so crown lengthening was completed where necessary.

FIGURE 4G. Because the patient had both erosion and attrition, metal occlusal in the posterior and lingual of anterior were completed.

FIGURE 4H. At completion, a nightguard was fabricated for the patient. Medication-induced xerostomia can decrease lubrication resulting in more attrition.

cluding surfaces and "alloy islands" in posterior dentition, all consistent with dental erosion (**FIGURE 4C**). Although some occlusal facets were present indicating attrition, most of the tooth structure loss was due to erosion.

Mandibular molars are often the most affected by GERD. Mandibular dentition shows many of the same patterns of tooth structure loss seen in the maxillary arch (**FIGURE 4D**).

Based on a diagnostic wax-up, an evaluation of retention and resistance form of remaining dentition, it was determined the occlusal vertical dimension should be increased (**FIGURE 4E**). This was evaluated by having the patient wear a splint for three weeks followed by evaluation of speech and function with provisional restorations.

Following provisional restorations at the increased occlusal vertical dimension, it was determined the remaining tooth structure was inadequate for the required retention and resistance necessary for nonsplinted crowns, so crown lengthening was completed where necessary (**FIGURE 4F**).

Because the patient had both erosion and attrition, metal occlusal in the posterior and lingual of anterior were completed (**FIGURE 4G**).

At completion, a nightguard was fabricated for the patient. Medication-induced xerostomia can decrease lubrication resulting in more attrition (**FIGURE 4H**).

Conclusions

Erosion is prevalent, often progresses asymptomatically, is synergistic with other surface loss processes like attrition and erosion, and is best managed by early identification and patient education. ■■■■

REFERENCES

1. Larsen MJ, Chemical events during tooth dissolution. *J Dent Res* 69:575-80; discussion 634-6, 1990.
2. Gandara BK, Truelove EL, Diagnosis and management of dental erosion. *J Contemp Dent Pract* 1(1):16-23, 1999.
3. Bartlett DW, Shah P, A critical review of noncarious cervical (wear) lesions and the role of abfraction, erosion, and abrasion. *J Dent Res* 85(4):306-12, 2006.
4. Featherstone JD, Singh S, Curtis DA, Caries risk assessment and management for the prosthodontic patient. *J Prosthodont* 20(1):2-9, January 2011.
5. Sorvari R, Kiviranta I, A semiquantitative method of recording experimental tooth erosion and estimating occlusal wear in the rat. *Arch Oral Biol* 33(4):217-20, 1988.
6. Eisenburger M, Shellis RP, Addy M, Comparative study of wear of enamel induced by alternating and simultaneous combinations of abrasion and erosion in vitro. *Caries Res* 37(6):450-5, 2003.
7. Mahoney EK, Kilpatrick NM, Dental erosion: part 1. Aetiology and prevalence of dental erosion. *NZ Dent J* 99(2):33-41, 2003.
8. Reich E, Trends in caries and periodontal health epidemiology in Europe. *Int Dent J* 51(6 suppl 1):392-8, 2001.
9. Buyer DM, Are you drinking your teeth away? How soda and sports drinks dissolve enamel. *J Indiana Dent Assoc* 88(2):11-3, 2009.
10. Eisenburger M, Degree of mineral loss in softened human enamel after acid erosion measured by chemical analysis. *J Dent* 37(6):491-4, 2009.
11. Klein DA Walsh BT, Eating disorders: clinical features and pathophysiology. *Physiol Behav* 81(2):359-74, 2004.
12. Klump KL, Kaye WH, Strober M, The evolving genetic foundations of eating disorders. *Psychiatr Clin North Am* 24(2):215-25, 2001.
13. Kendler KS, MacLean C, et al., The genetic epidemiology of bulimia nervosa. *Am J Psychiatry* 148(12):1627-37, 1991.

14. Lussi A, Schaffner M, et al, Dental erosion in a population of Swiss adults. *Community Dent Oral Epidemiol* 19(5):286-90, 1991.
15. Gregory-Head B, Curtis DA, Erosion caused by gastroesophageal reflux: diagnostic considerations. *J Prosthodont* 6(4):278-85, 1997.
16. Gregory-Head B, Curtis DA, et al., Evaluation of dental erosion in patients with gastroesophageal reflux disease. *J Prosthet Dent* 83(6):675-80, 2000.
17. Bartlett DW, Evans DF, et al, A study of the association between gastro-oesophageal reflux and palatal dental erosion. *Br Dent J* 181(4):125-31, 1996.
18. Knight DJ, Leroux BJ, et al, A longitudinal study of tooth wear in orthodontically treated patients. *Am J Orthod Dentofacial Orthop* 112(2):194-202, 1997.
19. Toumba J, Tooth surface loss — a challenge to oral health. *J Clin Dent* 17(4):85-7, 2006.
20. Edwards M, Ashwood RA, et al, A videofluoroscopic comparison of straw and cup drinking: the potential influence on dental erosion. *Br Dent J* 185(5):244-9, 1998.
21. Eisenburger M, Hughes J, et al, The use of ultrasonication to study remineralization of eroded enamel. *Caries Res* 35(1):61-6, 2001.
22. Attin T, Buchalla W, Putz B, In vitro evaluation of different remineralization periods in improving the resistance of previously eroded bovine dentine against toothbrushing abrasion. *Arch Oral Biol* 46(9):871-4, 2001.
23. Hara AT, Turssi CP, et al, Abrasive wear on eroded root dentine after different periods of exposure to saliva in situ. *Eur J Oral Sci* 111(5):423-7, 2003.
24. Eisenburger M, Addy M, Influence of liquid temperature and flow rate on enamel erosion and surface softening. *J Oral Rehabil* 30(11):1076-80, 2003.
25. McCo, G, The etiology of gingival erosion. *J Oral Implantol* 10(3):361-2, 1982.
26. Lee WC, Eakle WS, Possible role of tensile stress in the etiology of cervicalerosive lesions of teeth. *J Prosthet Dent* (52):374-380, 1984.
27. Staninec M, Nalla RK, et al, Dentin erosion simulation by cantilever beam fatigue and pH change. *J Dent Res* 84(4):371-5, 2005.
28. Bartlett DW, The role of erosion in tooth wear: etiology, prevention and management. *Int Dent J* 55(4 suppl 1):277-84, 2005.
29. Vailati F, Belser UC, Classification and treatment of the anterior maxillary dentition affected by dental erosion: the ACE classification. *Int J Periodontics Restorative Dent* 30(6):559-71, 2010.
30. Miller WR, Rose GS, Toward a theory of motivational interviewing. *Am Psychol* 64(6):527-37, 2009.
31. Amaechi BT, Higham SM, Eroded enamel lesion remineralization by saliva as a possible factor in the site-specificity of human dental erosion. *Arch Oral Biol* 46(8):697-703, 2001.
32. Gedalia I, Daukar A, et al, Enamel softening with Coca-Cola and rehardening with milk or saliva. *Am J Dent* 4(3):120-2, 1991.
33. Wiegand A, Attin T, Influence of fluoride on the prevention of erosive lesions — a review. *Oral Health Prev Dent* 1(4):245-53, 2003.
34. Tay FR, Pashley DH, Resin bonding to cervical sclerotic dentin: a review. *J Dent* 32(3):173-96, 2004.
35. Ogata M, Okuda M, et al, Influence of the direction of tubules on bond strength to dentin. *Oper Dent* 26(1):27-35, 2001.

TO REQUEST A PRINTED COPY OF THIS ARTICLE, PLEASE CONTACT
Donald A. Curtis, DMD, University of California, San Francisco, School of Dentistry, Box 0758, San Francisco, Calif., 94143-0758.

Specializing in the Selling and Appraising of Dental Practices

CALIFORNIA PRACTICE SALES INC.

Serving California Since 1974

"Your local Southern California Broker"

Phone (714) 639-2775
(800)697-5656
Fax (714) 771-1346
E-Mail: jknipf@aol.com
rpalumbo@calpracticesales.com
WWW.CALPRACTICESALES.COM

John Knipf & Robert Palumbo

LOS ANGELES COUNTY

BEVERLY HILLS – Leasehold & equip only! Located in multi-story historical med/prof. building with parking options. ID #3601
CANOGA PARK – Long established practice located on a major boulevard in a single duplex building with excellent signage. ID #3961
CLAREMONT – Leasehold & equip only! State-of-the-art practice in med bldg. 3 ops., Softdent software & digital Kodak sensors. ID #3994
DIAMOND BAR – Leasehold & equip only! Great opportunity for a GP or Specialist. Located in a 2 story bldg w/12 eq. ops. ID #3721
ENCINO – Leasehold & equip only! Corner location with good window views. A great starter opportunity w/3 spacious eq. ops. ID #3971
HOLLYWOOD – Equipment & some charts! Located in general purpose bldg with 5 fully eq. ops. Good exposure. ID #3761
LOS ANGELES GP – Building for sale! Well established practice with 32 years of goodwill. Excellent signage. Great staff. ID #3771
LOS ANGELES GP – Located in a 2 story busy shopping center with great exposure & valet parking. Equip with charts only. ID #3861
LOS ANGELES – Over 20 yrs of goodwill this turn-key practice is located in a 7 story med/dent building. Low sale price! ID #3791
LOS ANGELES – Long established practice located in a shopping center with heavy traffic flow. NET $58K. ID #2771
MALIBU GP – Located in a very desirable upscale area w/excellent exposure. Fee-for-service practice. High quality dental care. ID #3651
MONTEBELLO – Price reduced! Long established practice in a single story busy shopping center. Leasehold, equip & charts. ID #2701
SOUTH GATE – Leasehold & equip only! Corner location with heavy traffic flow. Priced for immediate sale. ID #3911
SOUTH GATE – Equipment & some charts! Established over 50 years ago, this practice is located in a free standing building. ID #3941
UPLAND / CLAREMONT Ortho – Long established practice located a med/dent building with low rent. ID #3681
VALENCIA GP – State-of-the-art office w/condo suite available for lease. Three year old equipment. Fee-for-service practice. ID #3741
WOODLAND HILLS PEDO – Well equipped Pedo office with 3 chairs in open bay area. Fully computerized. NET $305K. ID #3661
WHITTIER – Fee-for-service practice, 59 yrs gdwll. Located in a 1,450 sf single standing bldg w/private parking. Bldg for sale. ID #3931

ORANGE COUNTY

ALISO VIEJO – Beautiful spacious practice with 4 fully eq. ops. Great opportunity for GP or Spec. Leasehold & equip only! ID #3831
ALISO VIEJO – Price reduced! Modern design turn-key practice with great views and beautiful decor. ID #3301
ALISO VIEJO – Modern design office located 2nd fl of busy mall. Fee-for-service practice. Open 5 days/wk, 3 days of hygiene. ID #3981
IRVINE – Price reduction! Leasehold & equip. only. 5 eq. ops., 1,450 sq. ft suite located in busy Ralph's shopping center. ID #3401
IRVINE GP – Established in 1987, located in 3 story med/dent bldg. Next to a busy shopping center. NET OF $74K. ID #3901
IRVINE – Leasehold & equip only! Great opportunity for a Spec.! Beautiful décor office w/4 ops, located in a med/dent bldg. ID #3986
LAKE FOREST – Modern design office w/state-of-the-art equip., 4 fully eq. ops, and 2 plumbed eq. ops. Leasehold & equip. ID #3631
MISSION VIEJO GP – Well established fee-for-service practice is located in a single story busy shopping center. NET $180K. ID #2061
ORANGE GP – Well established practice located in a single story medical center with 4 fully eq. ops., 1 plumbed not eq. ID #3531
YORBA LINDA – Turn-key practice located in a free standing building w/heavy traffic intersection & excellent street visibility. ID #3711

RIVERSIDE / SAN BERNARDINO COUNTIES

CORONA – Price reduced! Equipment & some charts! Located a busy shopping center with heavy traffic flow. ID #3431
HEMET – Established 30 yrs ago, this beautiful practice consists of 3 eq. ops/1 plmbd not eq. located in a busy shopping center. ID #3851
RANCHO CUCAMONGA – Leasehold & equip. only! 6 eq. ops., 1,800 sq. ft. suite located in 2 story med/dent building. ID #3191
UPLAND – Leasehold & equip only! 3 eq ops office located busy single story shopping center with great mountain views. ID #3982
VICTORVILLE – Fee-for-service practice, located in a single standing building with over 55 years of goodwill. Bldg for sale. ID #3861

SAN DIEGO COUNTY

SAN DIEGO – Leasehold & equip only! Office consists of 5 eq. ops., w/Dentrix software. Good location w/heavy traffic flow. ID #3141

Call us about Debt Consolidation & Retirement Planning
VISIT OUR WEBSITE WWW.CALPRACTICESALES.COM
CA DRE #00491323

John Knipf
President
(Neff)

Also serving you: Robert Palumbo, Executive V. P. /Partner, Alice C. King, V.P., Greg Beamer, V.P., Tina Ochoa, V.P., & Maria Silva, V.P.

Classifieds

OFFICES FOR RENT OR LEASE

BAKERSFIELD PEDIATRIC DENTAL OFFICE FOR RENT/LEASE — Long established pediatric dental office. Four plumbed operatories. Newly remodeled. Quiet room. 1,000 sq. ft. office. Tremendous amount of underserviced young families in the area. $1250 a month. Please call 661-871-0780.

DENTAL SUITE IN SANTA ROSA — Renovated 1,500 sq. ft. office. Has some new equipment and furnishings. Very reasonable rent. Contact 707-494-8498 or email jsmuthy@aol.com.

DENTAL SUITES FOR LEASE IN SILICON VALLEY — Renovated ortho, pedo and general space with views in Los Gatos, an affluent community. Close to schools, downtown and freeway. Contact Trask Leonard at 650-282-4620, email at tleonard@baysiderp.com or email owner at 2340akmeadow@sbcglobal.net.

EXCLUSIVE DENTAL SUITES FOR LEASE — Short/long term lease, state-of-the-art equipment and accommodations. Conveniently located off the 101 freeway. Laura Miller 818-758-3557.

SACRAMENTO FOOTHILLS OFFICE FOR LEASE OR SALE — Beautiful, turn-key office in high-end retail center available for lease or purchase located in Sacramento Foothills. Owner finance okay. Contact 916-390-5993.

SANTA BARBARA OFFICE CONDO FOR LEASE/SALE — Prime location. Contact 310-546-3683 or email rmemsic@earthlink.net.

SANTA CLARA OFFICE FOR RENT OR LEASE — Fully equipped, six operatories, ample parking, free standing one story building, approximately 1,800 sq. ft. Close to Santana Row. Option to buy. Call 619-644-2906.

CONTINUES ON 268

How to Place a Classified Ad

For information on placing a classified, contact Jenae Gruchow at 916-554-5332 or Jenae.Gruchow@cda.org.

The deadline for classified advertising is the first day of the month, prior to the month of publication. After the deadline closes, ads will not be accepted, altered or canceled. Deadlines are firm.

Licensed agents and brokers may not place classified ads. For information on display advertising, please contact Corey Gerhard at 916-554-5304 or Corey.Gerhard@cda.org.

CDA reserves the right to edit copy and does not assume liability for contents of classified advertising.

CLASSIFIEDS, CONTINUED FROM 267

SF BAY AREA/VALLEJO PROFESSIONAL BUILDING — 1,000-5,000 sq. ft. existing dental/orthodontic office. Inquiries call 707-994-1218.

SPACE AVAILABLE FOR RENT — Fully equipped, high technology, five chair operating suite to share. Beverly Hills area. Completely digital, CEREC AC. Contact 310-652-6472.

OFFICES FOR SALE

LEASEHOLD/LEASEHOLD WITH EQUIPMENT — Nicely equipped 1,250 sq. ft. four operatory office with nice cabinetry and full digital in the heart of the hip Mission district in San Francisco. Dentist moving into newly purchased building and is extremely motivated. Save tens of thousands. Very reasonable lease. Call 415-509-7593 or email ericdebb@msn.com.

OPPORTUNITIES AVAILABLE

DENTAL JOBS AVAILABLE — Aspen offers tremendous earning potential and a practice support model that empowers dentists. We eliminate obstacles for dentists to own their own practice. Call 866-745-5155 or visit aspendentaljobs.com. EOE

OPPORTUNITY AVAILABLE — A great place for a family to live? A practice with a great income and a future? Family, friends and a community? This is the place. Join our team and be "working together to be better." Try Missouri, you'll like it. Contact Sheila at 573-201-9298.

CONTINUES ON 272

WESTERN PRACTICE SALES

John M. Cahill Associates

BAY AREA

A-8941 SAN FRANCISCO– Ready to Move In. Fully Equipped. 2 ops. Plumbed for 1 add'l **$75k**

A-9361 SAN FRANCISCO– Blocks from Union Square! 17 story building. 975 sf w/4 ops **$550k**

B-9381 OAKLAND - GP in Bustling Area! 1148 sf w/2 ops. **Only $75k**

B-9541 BRENTWOOD - Facility Only Centrally located in a highly visible shopping complex w/ ample parking in a well-established neighborhood. 2,203sf & 6 ops **$230k**

B-956 BERKELEY- Professionally planned, efficiently laid out for ease of workload and patient flow overlooking Berkeley Hills. 792 sf w/3 ops **$220k**

C-7811 SOLANO CO - 2,997 sf w/6 ops + 2 Hyg ops + 1 add'l op! Buy the whole practice for $1.3m or only 50% for $650k. **Call for Info!**

C-8901 SANTA ROSA– Residential area. 40+ new pats/mo. Highly Visible! 1291sf & 3 + 1 op. **$475k**

C-9471 SANTA ROSA -Stable patient base, well-respected practice. Dental building w/excellent signage on major thoroughfare. 1,500 sf w/5 ops **$495k**

C-9501 MARIN COUNTY–Remarkable oppty awaits you! Near HWY 101.~ 800 sf w/3 ops. **$300k**

D-842 PLEASANTON –1,488sf w/ 2 ops **$295k**

D-845 SAN JOSE - *Facility* -Attractive office. Traditional décor. Retail Plaza. 2,240 sf & 5 ops. **$120k**

D-877 LOS ALTOS -Pristine Professional plaza. Office is ~ 2,400sf - 6 ops **2009 Collections - $819k!! Asking only $425K**

D-9091 ATHERTON -Turnkey operation 969 sf & 3 ops ***Call for Details!***

D-925 SANTA CLARA - Retail Shopping Center in the heart of the Silicon Valley. 1,500 sf & 3 ops **$499k**

D-9331 SARATOGA– FACILITY- General Dentistry & Specialists! State of the Art Equipment in excellent condition 1,187sf w/3 ops **$98k**

D-939 SAN JOSE - Doctor averages 5 patients daily. Office is ~1,522 sf w/5 ops **Only $195k**

D-960 *Facility only* SAN JOSE - Establish primary or satellite office with minimal start-up costs. This would cost more than our asking price to duplicate! *Reasonable rent and great lease* with **opportunity to purchase condo suite also!** 1,158sf w/3 fully equipped ops **$118k**

NORTHERN CALIFORNIA

E-729 AUBURN - Busy retail shp ctr w/excellent signage & good traffic flow. 1750sf, 4ops. Plumbed for 2 add'l ops **$250k**

E-7121 SACRAMENTO AREA – Largely FFS. 1800sf, 4ops (+2 add'l plumbed). . **$695k**

E-915 ELK GROVE—Averages 8 patients w/ approx 5-6 new pats/month. Located in an attractive professional building. 1,200sf / 4 ops. **$650k**

E-8641 SACRAMENTO-FACILITY Single Story office near county buildings. 2,100+ sf w/ 3 ops & plumbed for 1 add'l **$50k**

E-955 ELK GROVE First-floor suite in desirable commercial corridor. Giant foyer/spacious office w/ spectacular décor. 3 ops. Plumbed for 2 add'l **$375k**

E-961 SACRAMENTO -Great opportunity! Doctor averages 12-15 patients w/ 6-8 Hygiene patients per day. . Office is located near two major thoroughfares and has 5ops**. $325K**

G-751 RED BLUFF/CHICO- Complete remodel ~5 yrs ago. FFS GP. 2350sf /4 ops. Plumbed for 2 add'l. **Practice $75k / Real Estate $185k**

G-875 YUBA CITY–Estab. 30 + years, GP, FFS, 3575sf /9 ops, great location. **$1.5m**

G-883 CHICO VICINITY – Quality FFS GP. Attractive Prof Plaza. 1,990 sf w/ 5 ops **$535k**

G-952 PARADISE- Well-established fee-for-service practice. Ample parking w/ remote controlled, privately locked garage. 1,138 sf w/3 ops **$185k**

H-668 NORTHEASTERN CA–4 ops 1600sf office. 2007 gr rcpts exceed $650k! **$395k**

H-856 SOUTH LAKE TAHOE Over 50 new patients/mo Respected & Growing! 1568 sf & 4 ops **$425k**

I-685 TURLOCK - 1700sf, 7 ops. Recently remodeled. Free standing bldg. Mostly Adec Eqpmt. **REDUCED! NOW ONLY $305k**

CENTRAL VALLEY

I-772 *Facility* STOCKTON-Desirable, affluent health care area. 2,140sf/4 ops **$150k**

I-889 MERCED- Heart of town, bustling with activity & foot traffic. 3 ops **$265k**

I-923 MODESTO—1495sf/ 4op+1, Newer, All digital. **REDUCED! $250K**

CENTRAL VALLEY CONTINUED

I-945 TRACY - Young, growing, family-oriented practice. Highly motivated patient base. 1,300 sf & 4 ops **$350k**

I-949 MODESTO -Spacious office w/ brand-new build-out and equipment that has never been used which would cost more than our asking price to duplicate! Reasonable rent/Great lease. Retail Shopping Center. 1,250 sf w/ 4 fully equipped ops **$149k**

I-951 MODESTO- Street-level suite. Dental Professional building. 886sf w/ 3 ops **$265k**

J-928 ATWATER - Well-established & respected for gentle treatment. Prof Bldg in desirable area. 1,313 sf w/3 spacious ops **$230k**

J-943 CLOVIS FACILITY ONLY—This Practice would cost more to duplicate! Located in a highly visible shopping center. Office is ~2,098sf w/ 6 ops **$95k**

SOUTHERN CALIFORNIA

K-887 ESCONDIDO-Beautifully landscaped dental prof bldg 1,705 sf w/5 ops **$175k**

K-916 SANTA MARIA—Location and reputation are only two of the winning attributes of this stunning practice! 1,545 sf, w/ 4 fully equipped ops, **$300k Real Estate also available!**

SPECIALTY PRACTICES

I-7861 CTRL VLY ORTHO- 2,000sf, open bay w/8 chairs. Garden View. 45 years Goodwill. FFS. 60-70 patients/day. Prof Plaza. **$370k**

D-892 MORGAN HILL ORTHO- Remarkable Oppty! Floor to Ceiling windows—wooded courtyard. 1900sf & 6 chairs in open bay. **$275k**

H-913 SIERRA FOOTHILLS ORTHO– Strong, loyal base referral base. Practice averages 30 – 60+ pats/day. Pristine, remodeled building w/ ample parking. 2,600 sf w/ 5 chairs/bays **$500k**

K-929 SANTA MARIA – PROSTHODONTICS - Where "the patient comes first". Restorative/Implant Practice, FFS, 3 ops 1400 sf **$450k**

I-9461 CENTRAL VALLEY/ORTHO - Seller has strong referral base and happy patients! Well-respected for excellent, quality service in this family-oriented community. 1,650 sf w/5 chairs/bays plus (2) additional plumbed. **$140k**

Timothy G. Giroux, DDS

Jon B. Noble, MBA

Mona Chang, DDS

John M. Cahill, MBA

Edmond P. Cahill, JD

800.641.4179

View all of our available practices at:

w e s t e r n p r a c t i c e s a l e s . c o m

CARROLL & COMPANY

"MATCHING THE RIGHT DENTIST TO THE RIGHT PRACTICE"

Complete Evaluation of Dental Practices & All Aspects of Buying and Selling Transactions

Serving you: Mike Carroll & Pamela Gardiner

3041 SOUTH BAY GP

Well est. & successful practice in gorgeous state-of-the-art facility located in a most desirable area. Modern equipment updated in 2007 and near paperless office. Equipment includes Gendex digital x-rays, Panorex, Cerec & Dexis. 1,653 sq. ft. facility w/6 fully-equipped ops. Avg. GR for past 5 years 1.6M w/59% overhead. 2010 GR as of Aug. on track for 1.5M+. Quality staff. Long term lease available. This is an outstanding opportunity for the experienced dentist looking for a high quality practice. Asking $1.3M.

3049 SAN JOSE GP

Well-located, across from O'Connor Hospital, general practice in 2,118 sq. ft.state-of-the-art facility w/ 3 fully-equipped ops. 2 pvt. offices (1 can be plumbed for 4th op.). This office is beautifully designed and is stunning. In addition to his general practice, owner treats sleep apnea patients. He is selling just the general operative portion of the practice and is willing to help for a smooth transition. Ideal for an experienced dentists looking to merge an existing practice.

3048 SAN JOSE GP

Owner retiring from a small well-est. practice with great upside potential. 900 sq. ft. office with 3 ops. near medical center. 3 Dr. days/week. Owner willing to help for a smooth transition. Asking $95K.

SOLD

3050 EAST SAN JOSE FACILITY

Exceptional opportunity for a beautiful state-of-the-art, first class facility with 8 large ops. & 2 pvt. rooms, in a well traveled area. 1 level shopping center almost fully-equipped office with high visibility signs near E. Capital Expressway and 101. If you want exposure, this is the place to be. Asking $190K.

3045 VACAVILLE GP

Turn-key, traditional dental practice with loyal staff and sense of community. Well maintained 900 sq. ft. tastefully decorated office with 2 fully-equipped ops. 2009 GR 224K+, 2010 projected GR as of Aug. $270K+ with 50% avg. overhead. Owner retiring and willing to help for a smooth transition. Asking $172K.

3006 MONTEREY COUNTY ORTHO

Est. Ortho practice in 2,668 sq. ft. office with 5 open bay chairs in a professional dental complex. Panorex and Cephlometric X-ray machines. Stable and loyal referral base. Annualized GR as of Oct 2009 are $335K+. Owner retiring and willing to help for a smooth transition. Asking 227K.

3028 NAPA-SOLANO COUNTY GP

Owner retiring from well-est. practice in 1,400 sq. ft. facility with 5 ops. All fee-for-service pts. with great word-of-mouth reputation. 2009 GR $731K+, June 2010 FY on schedule for $771K+ with just 4/doctor-days. Asking $518K.

3047 WEST SAN JOSE GP

Owner retiring from well-established practice in professional dental building with 3 ops in 950 sq. ft. office. Ideal location near O'Connor Hospital, Town & Country Village and Valley Fair Shopping Center. Avg. GR $169K+ w/60% overhead. Asking $95K.

SOLD

3037 PLACER COUNTY GP

Well est. Placer County General & Cosmetic Practice. 6 fully-equipped state-of-the-art ops., in single story 3,500 sq. ft. stand alone professional building. Avg. GR for past 4 years $1.4M+ with 61% overhead and just 4 doctor-days/week. Asking $1,134,000.

SOLD

Upcoming:

Santa Cruz County GP & Sonoma County GP

Contact Us:

Carroll & Company
2055 Woodside Road, Ste 160
Redwood City, CA 94061

Phone:
650.403.1010

Email:
dental@carrollandco.info

Website:
www.carrollandco.info

CA DRE #00777682

HENRY SCHEIN®
PROFESSIONAL PRACTICE TRANSITIONS

"DENTAL PRACTICE BROKERAGE"
Making your transition a reality.

CDA MAY2011 Booth #2338

More information is available on our website regarding practices listed in other states, articles, upcoming seminars and more.

For more information regarding the listings below:
VISIT OUR WEBSITE AT:
WWW.PPTSALES.COM
(Practice Opportunities)

Practice Sales • Mergers
Partnerships • Appraisals
Patient Record Sales

- **BIG BEAR CITY:** *For Sale* - General Dentistry Practice. 26 years at current location. Gross Receipts $428K. 3-equipped operatories. Doctor owns the building. New lease available or option to purchase. #14345
- **EL DORADO HILLS:** *For Sale*-General Dentistry Practice. 2009 GR $790,758 adjusted net income of $300K. Intra-Oral camera, Pano, Softdent software, 4-equipped ops. 6-hygiene days. Practice has been in its present location for past 18 years. Owner retiring. #14324 SOLD
- **FOLSOM:** *For Sale*-General Dentistry Practice. Gross Receipts in 2010 were $703K, 3 1/2 day week with adjusted net income of $300K. 5 days of hygiene and approx. 1,500 active patients. Leased office is 2,000 sq. ft. with 4 equipped operatories - 5 possible. Patient Base software. Owner to retire. #14350
- **FOLSOM:** *For Sale* - General Dentistry Practice. Gross Receipts in excess of 1.5M the past three years. Adjusted Net of $550K. 2,700 sq. ft. office with 7 ops, Digital, Dentrix, Intra-Oral camera, Laser, 5+year old equipment, 8 days hygiene. Beautiful office, great location. Owner retiring. #14336
- **FOLSOM:** *For Sale* - General Dentistry Practice 2009 Collections $513K. Adjusted net income $184K. 4 ops (plumbed for 5), Intra-Oral camera, fiber optics all ops. Patient base software. Owner retiring. #14329 SOLD
- **FRESNO:** *For Sale* - General Dentistry IV Sedation Practice. (MERGER OPPORTUNITY) Owner would like to merge his practice into another high quality general dentistry or IV sedation practice. The merger would be into Buyers office. Seller would like to continue to work as either a partner or associate after the merger. 2010 collections were $993K with a $422K adjusted net income. There are 7 days of hygiene.
- **GRASS VALLEY:** *For Sale*-General Dentistry Practice. 2009 GR of $307,590 (3 days/wk) with adjusted net income of $105K. 3 Ops. refers out most/all Ortho. Perio, Endo, Surgery. Laser, Intra-oral camera, Diagnodent, EZ Dental Software. Good Location. Owner retiring. #14337 SOLD
- **GREATER FAIR OAKS-SUNRISE AREA:** *For Sale*-Gross Receipts in excess of $1.1 Million dollars for the past three years. Adjusted net $450K. 2,400 sq ft office-5 ops. Hygiene days-6, Owner works 32 hours per week. Eagle Soft, Laser, Pano Intra-Oral camera, fiber optics. Owner retiring. #14343
- **GREATER SACRAMENTO:** *For Sale*-Pediatric Practice. 2010 GR of $1,095,914, with a 45% overhead. Prevention oriented practice with 2,600 sq. ft. Digital office with Dentrix. Equipment is nine years old. Delta Premier is only insurance. Owner retiring. #14349
- **LAGUNA NIGUEL:** *For Sale*-General Dentistry Practice. 2010 gross receipts were $503k. 4 operatories, Pan, computerized with EZ dental software. 1,500 sq. ft. lease. 10 years in present location. Owner retiring. #14352
- **LAKE COUNTY:** *For Sale*-General Dentistry Practice. Gross Receipts 904K with adjusted net $302K. Practice has been in same location for past 23 yrs, and 25 yrs in previous location. 2,600 sq ft with 8 equipped treatment rooms. Intral-Oral camera, Pano, and Data Con software. Owner to retire. #14338
- **LIVERMORE:** *For Sale* - General Dentistry Practice. 2009 Collections were $688K with an adjusted net income of $287K. There are 4 ops in this nicely updated 1,082 sq. ft. office space. Dentrix software, 6-days/wk hygiene. Owner has been in same location for 36 years with long-term employees. Owner is retiring. #14326 SOLD
- **LOS ANGELES:** *For Sale* - General Dentistry Practice.1,200 sq ft 4ops, 29 yrs in present location. Gross Receipts $274K with adjusted net income of $89K. Owner to retire. #14348
- **LOS ANGELES:** *For Sale* - General Dentistry Practice: This practice 80% Dentical and has approximately 2000 active patients. Owner has operated in same location for 31 years. 2009 receipts were $709,000. 6 equipped tx rms, laser, Intra-Oral camera Pano and Ceph. Call for details. #14319
- **MODESTO:** *For Sale* - General Dentistry Practice. 5 operatories, 32-years in practice. Gross Receipts $884K w/adjusted net income of $346. Dentrix, Cerec, and Intra-Oral camera. Owner to retire. #14308
- **NAPA:** *For Sale* - General Dentistry Practice. Gross Receipts $800K, with adjusted net income of $250K. Fee for Service. 1300 sq ft 4 ops 6 hygiene days. 38 yrs in present location, 30 yrs in previous location. Owner to retire. SOLD
- **NORTHERN CALIFORNIA:** *For Sale* - Pediatric practice. Owner has operated in same location for 32 years. Approx. 1,760 active patients, 1,160 sq. ft., Panoramic X-ray, Dexis Digital and Dentrix software in this 5-chair office. 2010 Gross Receipts $610K. Owner retiring. Call for details. #14322
- **OCEANSIDE:** *For Sale* - Modern looking office. 4 op, office space and equipment only. Belmont chairs. Gendex x-ray system, intraoral camera, approx 1200 sq ft. Low overhead-Rent is $1,900/month, and it's a 5 year lease. Staff is available for rehire-front desk $15/hr, assistant 13/hr. Update all the computer systems after purchasing the office in 07. Computers and monitors in every room. #14346
- **PALM SPRINGS:** *For Sale* - General Dentistry Practice. Fee for Service. Gross Receipts $282K with adjusted net income of $157K. 1,280 sq. ft., 3 equipped operatories. Intra-Oral camera, Pano, Practice-NEB software. Doctor willing to transition by working 1-2 days a week. #14332
- **PLUMAS COUNTY:** *For Sale*-3 equipped ops. Space available for 4th op. 1,245 sf office in good location. Gross Receipts $475K. Practice in present location over 50 years. Owner is retiring. #14318
- **REDDING:** *For Sale*-Owner looking for Assoc. trans. into Partnership w/Buy-Out. GR $1 Million dollars income $436K. 5.5 days hygiene, 2,200 sq. ft. #14293
- **RENO:** *For Sale* - General Dentistry Practice and Dental Building: 2009 Gross Receipts $517K with adjusted net income of $165K. 4 ½ hygiene days/week. 1, 800 sq. ft. with 6 equipped ops. (7 Avail). Dentrix software, Pano. Practice has been in its present location for 40 years. Owner retiring. SOLD
- **ROCKLIN:** *For Sale*- General Dentistry Practice. Gross Receipts $593K in 2010 with $240K adjusted net income. Office is 1,630 sq. ft., with 4 operatories equipped with fiber optics. Owner has been in present location for the past 13 years. 3 1/2 days hygiene. Intra-Oral camera, Dentrix software. Owner to retire.
- **ROSEVILLE:** *For Sale* - General Dentistry Practice. Great Location. 2009 GR $900K with adjusted net income of $300K. 1,975 sq. ft. with 4 ops, 8 days hygiene/wk. Digital, Intraoral camera, Dentrix, Trojan, fiber optics, P & C chairs - all less than 5 years old. Owner is retiring. #14327 SOLD
- **SACRAMENTO/ROSEVILLE:** *For Sale* - One of many partners is retiring in this highly successful General Dentistry Group Practice. Intra-Oral camera, Digital Pano-Dexis, electronic charts, owner Financing. Call for further information. #14334
- **SAN FRANCISCO:** *For Sale-Patient Base for Sale*-Owner passed away last June and the practice has continued on 4 days a week with an associate. Lease can't be renewed. There are approx. 1,000 acive patients in the practice. The patient base can be purchased at no risk to buyer since the purchase price is paid according to the receipts collected on the patients that transfer. #14312 SOLD
- **SAN DIEGO:** *For Sale*-General Dentistry Practice. This office is plumbed for 4 ops. 3 ops. are equipped with Promo Equipment. Lease is $2,200 per month. 2009 Receipts were $185,645. PPO and Fee for service practice. #5315 SALE PENDING
- **SAN DIEGO:** For Sale-General Dentistry practice. Gross Receipts $414K. Practice has been operated by the same owner for the past 6 years. Leased 950 sq. ft. office with 3 equipped operatories. Dentix software, Intra-Oral camera, Panoramic X-Ray. Owner to relocate.
- **SAN DIEGO:** *For Sale*-General Dentistry Practice. 6 ops, Intra-Oral camera, Eagle Soft Software. Office square feet 2,300 with 3 years remaining on lease. 2009 Gross Receipts $1,448,520, with an adjusted net income of $545K. Doctor would like to phase out then retire. #14331
- **SAN DIEGO/CITY HEIGHTS:** For Sale-General Dentistry practice. Owner has operated in same location for 12 years. Approx. 1,000 active patients, Panoramic X-ray, Intra-Oral camera, in this 3-chair office. #14321
- **SANTA BARBARA:** *For Sale* - General Dentistry Practice. This excellent practice's 2009 gross Receipts $891K with steady increase every year. Practice has 6 days of hygiene. 1,690 sq. ft., 5 ops, Laser, Intra-Oral camera, Schick Digital X-Ray, Datacon software. Doctor has been practice in same location for the past eleven years of his 31 years in Santa Barbara. Doctor is retiring. #14333 SOLD
- **SOUTH LAKE TAHOE:** *For Sale*-General Dentistry Practice. 2007 collections $534K. Office is 647 sq ft with 3 ops. Practice has been in its present location for the past 26 years. Owner to retire. SOLD
- **TORRANCE:** For Sale- General Dentistry Practice: Owner has operated in same location for 20 years. Approx. 1,000 active patients, 1,080 sq. ft., Brican System, and Camsight software in this 2 equipped, 3 available-chair office. Gross Receipts $434K with 38% overhead. Owner relocating. #14320
- **TURLOCK:** For Sale- General Dentistry Practice. 2009 Gross Receipts $2,728,319 with an adjusted net income of $925,251. 13 days of hygiene in this tastefully decorated 3,900 sq ft office space. Owner is retiring form clinical dentistry. SOLD
- **VISALIA:** For Sale- General Dentistry Practice. Gross Receipts $616K with an adjusted net income of $ 321K. Office is 1,380 sq ft with 3 equipped operatories, Intra-Oral camera, Digital X-Rays, Mogo software, equipment & leaseholds look new. 5 years in present location. Owner to relocate. #14347

CALIFORNIA / NEVADA REGIONAL OFFICE

HENRY SCHEIN PPT INC.
California Regional Coporate Office
DR. DENNIS HOOVER, Broker
Office:(800) 519-3458 Office (209) 545-2491
Fax (209) 545-0824 Email: dennis.hoover@henryschein.com
5831 Stoddard Road, Ste. 804 Modesto, CA 95356

Henry Schein PPT Inc., Real Estate Agents
and Transitions Consultants
Dr. Tom Wagner (916) 812-3255 N. Calif.
Mario Molina (323) 974-4592 S. Calif.
Hallie Johnson-Nelson (209) 545-2491 N. Calif.
Thinh Tran (949) 533-8308 S. Calif.

CDA JOURNAL, VOL 39, Nº4

CLASSIFIEDS, CONTINUED FROM 268

OPPORTUNITY AVAILABLE IN NORTHWESTERN WASHINGTON — Seeking experienced dentist for busy, established, rapidly growing, fee-for-service group dental practice. Excellent immediate income opportunity ($180K to $375K + per year) depending on productive ability and hours worked. Secure long-term position. You can concentrate on optimum patient treatment without practice management duties. Newly equipped, modern office with excellent staff and lab services provided. If you are bright, energetic with a desire to be productive, very personable, people oriented and have great general and specialty clinical skills, please fax resume to Otto J. Hanssen at 425-484-2110.

SEEKING MANAGING DENTISTS — If you're looking for a long-term commitment and desire to be productive the opportunity is yours! Seeking full-time, managing dentists to join large group practice in the following areas: Los Angeles, Orange County, Inland Empire, San Diego and doctors willing to relocate to Arizona. Steady patient flow in high volume HMO environment. Required: 3-5 yrs experience and proficient in molar endo. Benefits include: medical, dental, vision, 401K, malpractice coverage and competitive pay! For available positions please call: 714-428-1305, submit your resume to kristin.armenta@smilebrands.com or fax to 714-460-8564.

OPPORTUNITIES WANTED

IN HOUSE PERIODONTIST/IMPLANT SURGEON AVAILABLE FOR YOUR PRACTICE — In the Greater San Francisco Bay Area. Implant Surgeon/Bone Grafting/ Perio Surgery/3rd Molar Extractions. bayareaperio@gmail.com or call 617-869-1442.

CONTINUES ON 274

Professional Practice Sales of The Great West

Specialists in the Sale and Appraisal of Dental Practices

Serving California Dentists since 1966

Where turning "For Sale" into "Sold" is a practiced art!

5999 **PLEASANTON** Great visibility in busy strip shopping center. 3-Ops with 4th available. Computerized Ops, intraoral cameras, digital radiography. 2010 collected $692,000 with Profits of $400,000. First 2-months of 2011 collected $165,000.

6000 **MILLBRAE** Downtown sidewalk location, computer charting, digital radiography, strong patient base. 2010 collected $725,000. 4-Ops, 3-equipped.

6002 **SAN JOSE'S EVERGREEN VALLEY** Located near East Capitol Expressway & Highway 101. 4-day Hygiene Schedule. Averages $600,000 year in collections. Housed in 3-year old suite. 4-Ops with computers.

6003 **PINOLE - HERCULES AREA** 4-days of Hygiene. 90%+ effective Recall. Produced $740,000 and collected $709,500. Low AR balance. Endo referred.

6004 **SAN JOSE'S SANTA TERESA AREA** Asking slightly more than what it would cost to replicate this office today. Digital & paperless 3-Op suite. 2010 produced $385,000 with collections of $277,000 and Profits of $190,000+. Gorgeous facility. Lease allows occupancy thru 9/30/2024.

6005 **FAIRFIELD - WEST OF I-80** Seeks full-time Successor. Operating on 2.5 week schedule by Owner with other commitments. Has averaged $470,000 per year last 3-years. 2-days of Hygiene, 20 new patients/month. Attractive 3-Op suite. High visibility location.

6006 **STOCKTON** Beautiful office near intersection of West Hammer & Lower Sacramento. Busy retail location. Ideal for nearby Dentist seeking office upgrade or someone with a Business Plan. 4 Ops, digital radiography, computer charting. No goodwill.

6007 **LIVERMORE** Great central location. Housed in free-standing building. 2010 topped $400,000 in collections. 4-Ops, paperless charting and digital radiography.

6008 **MENDOCINO COAST** Busy practice located in desirable cultural haven on ocean. Busy hygiene department with Owner working relaxed schedule. $700,000+ performer.

6009 **SAN JOSE'S O'CONNOR HOSPITAL MEDICAL VILLAGE** Beautiful 3-op suite perfect for nearby Dentist seeking quality upgrade. 200+ patients. 1-day of Hygiene. Produced $250,000 by part-time Owner.

For complete details on any of these opportunities, go to www.PPSsellsDDS.com

Professional Practice Sales of The Great West

Ray and Edna Irving

(415) 899-8580 ~ (800) 422-2818

www.PPSsellsDDS.com

Thinking on selling your practice? Call "PPS of The Great West" today.
This shall be the best decision you make regarding this important change in your life!

"I listed with a competitor for 12 months. Had two people visit my practice. First weekend PPS had my listing, I had 3 people visit and an offer by the end of the first week. Thank you for allowing me to move on to the next step of my life."

"It was a pleasure to work with PPS. I had to sell because of health complications. Mr. Irving listed my practice on Jan 1st, we closed escrow on Feb 27th. It took him less than 60 days to complete the sale as promised."

"When I decided to sell my ortho practice, I sought the services of a large company. Over the 12-month contract, I had one buyer visit. Word was out. It had a devastating effect on my bottom line. Fortunately, I found Ray and Edna Irving! When I finally sold, I choose between two good offers. My regret was the time and money lost with the other guys."

"When I signed the Listing on June 1st, Ray stated he would have the practice sold by Labor Day. The sale was concluded on Sept 1st, two days before Labor Day. Wow!"

"I will always remember your statement when I questioned your contract being only four months. You stated: 'If I can't sell your practice in that time, you should get someone else.' Well, you did with time to spare!"

"Before I called Ray, I had a listing with another prominent Broker. After eleven months without a sale, I called Ray. He sold it in about a month! Would I recommend Ray? Yes!"

"In April, I asked Ray Irving to sell my practice. At the same time my friend decided to sell his practice. He employed another firm. My practice sold June 22. My friend's practice still hasn't sold and he was putting his dreams on hold."

PPS of The Great West's reputation is built upon grounded ethics and effectiveness. Our trademark "client services" include accurate assessments, impeccable marketing plans, complete transparency, generating quick responses, realizing multiple Offers, securing 100%+ financing in days, expert papering of our transactions and sound counsel. Everything is done to protect our Client and to effect a successful transfer. Our intent is simply to provide the best service imaginable for this very important engagement.

CA DRE License #1422122

CLASSIFIEDS, CONTINUED FROM 272

PRACTICES FOR SALE

GENERAL PRACTICE IN EL CAJON/ SAN DIEGO FOR SALE — Mainly cosmetics, C&B, implants. No pedo, no HMOs. All PPOs and cash. Collected over $650K in the last three consecutive years. Reduced price from $525K to $395K. Buy directly from owner. Options of long term-lease or buy the building as well. Call 619-401-0444.

PEDIATRIC PRACTICE IN EUREKA, CALIFORNIA — Don't miss this opportunity! Perfect situation for one or two pediatric dentists looking for an exceptional life style, higher than average income/benefits working in a state-of-the-art facility with six bays, one quiet room and lots of extras! Revenues of $1.5M with low overhead and limited competition. Owner retiring and motivated. Check it out! Email growingsmilesdds@sbcglobal.net.

RETIRING DENTIST SELLING SAN JOSE PRACTICE — No cash or "take-out loans" needed. Good six figure income from day one. Brief transition period, short workweek, no evenings or weekends. Modern, state-of-the-art equipment. Good location with assumable lease. Contact 408-929-5557 or email burrdoris@comcast.net.

STOCKTON PRACTICE FOR SALE — Visible and easily accessible 1,100 sq. ft. practice. Ideal opportunity for a dentist looking to start a practice or for someone looking to expand. Great location, next to shopping. Equipment/charts included. Buyer would take over building lease. Selling dentist is retiring. Contact 209-957-0765 or 209-598-1640.

EXPERIENCE
THE DIFFERENCE

- Lee Skarin and Associates have over 30 years *experience* in dental sales.
- Within the last 12 months we have sold more practices than any broker in the state.
- Our *experienced* practice appraisals are backed with credentials unequaled among dental practice brokers.
- We provide in-house legal counsel to advise you in all aspects of the sale and purchase, including the tax consequences of the sale.
- Excellent financing is available, in most cases for 100% of the purchase price.
- With a reputation for *experienced*, concientious, and ethical performance, we give our clients personal attention in all aspects of the purchase.

With scores of buyers, profiles of their practice interests and financial ability, Lee Skarin and Associates is able to find the right buyer for your practice.

Practices for sale in the following areas:

Anaheim	Palm Springs	Santa Ana
Chatsworth	Panorama City	Santa Barbara
Granada Hills	Pasadena	Thousand Oaks
Irvine	Reseda	Ventura
Oxnard	Riverside	

LS LEE SKARIN AND ASSOCIATES

DENTAL PRACTICE BROKERS
CA DRE #00863149

Experience the difference. Call Lee Skarin and Associates, NOW, for responses to all of your questions - *No obligation*!

(805) 777-7707 (818) 991-6552 1-800-752-7461

ADVERTISER INDEX

A. Lee Maddox, A Professional Law Corporation	maddoxpracticegroup.com	224
Academy of General Dentistry	agd.org	257
California Practice Sales	calpracticesales.net	266
Carroll & Company Practice Sales	carrollandco.net	270
CDA Practice Support Center	compass.com	205
D&M Practice Sales and Leasing	dmpractice.com	274
Discus Dental	discusdental.com	242
Elite Builders	elitebldrs.com	265
Golden State Practice Sales	925-743-9682	268
Implant Direct	implantdirect.com	250
Invisalign	invisalign.com	258
Lee Skarin and Associates, Inc.	leeskarinandassociates.com	275
Maddox Practice Group	maddoxpracticegroup.com	231
Midwest Dental	midwest-dental.com	203
Nevada Dental Assocation	nvda.org	241
Professional Practice Sales of the Great West	415-899-8580	273
Professional Practice Transitions	pptsales.com	271
Select Practice Services, Inc.	betterobin.com	279
The Dentists Insurance Company	tdicsolutions.com	198, 206
TOLD Partners, Inc.	told.com	267
Ultradent Products	ultradent.com	280
University of Southern California	uscdentalce.org	232
Western Practice Sales/John M. Cahill Associates	westernpracticesales.com	238 ,249, 269
Wood & Delgado	dentalattorneys.com	268

FOR ADVERTISING INFORMATION, PLEASE CONTACT COREY GERHARD AT 916-554-5304.

DR. BOB, CONTINUED FROM 278

calamity befall them as a result. I take it that he means the doctor has, at any given moment, a device attached to a sharp pointy thing going like crazy right inside your mouth, so any plans you concoct to even the playing field should involve his mind, not his hands.

Listen to this from chapter four, "The Diagnostic Game,": "Your average dentist is a control freak, i.e., he wants everything precisely compartmentalized, and his questions to you to form a neatly packaged diagnosis are all composed to achieve that end. This is your opportunity. If he asks, 'Cold?', you say, 'Hot.' If he says, 'Hurt?', you say, 'Yes and no.' If he says 'Right side?', you answer, 'Both sides.' 'All the time?' 'Only on Tuesday afternoons.'"

You see where this is going? His search for familiar patterns is falling apart.

Who has the power now?"

Chapter four closes with this bit of diabolical advice: "Call for an appointment, indicating with mounting hysteria that a major chunk of one of your teeth has calved off like an iceberg and you need to see him forthwith. Now, rummage around in your kitchen junk drawer until you find an amorphous chunk of something resembling silver amalgam or a piece of tooth-colored resin. Wrap this carefully in a piece of tissue and insert into a Ziploc sandwich bag, taking it with you to your appointment. On your way to the office, rehearse your story of how you were just eating something soft and bingo! You felt this piece of filling or tooth in the food. There's no limit to the histrionics that can be applied here."

"When you are seated in the chair and the doctor is carefully examining the piece of shrapnel you've given him, note the look in his eye — he thinks he is going to make you a crown. He will ask you which area in your mouth this chunk of material came from. You thoughtfully run your tongue around your teeth and confess you don't rightly know. No problem he says, thrusting his mirror confidently in your mouth. Now watch. "He makes a circuit of your teeth, blows air on a couple of them. Nothing. Takes another survey, a little slower this time. Then another, asks a couple of questions and small beads of perspiration break out on his upper lip and his forehead.

> Unlike ordinary patients who suffer their assorted discomfitures benignly, he has taken it upon himself to instruct them how to retaliate in kind without actually having any physical calamity befall them as a result.

"Thirty minutes later, beaten and crestfallen, he admits he can't find anything wrong. At this point, you cheerfully announce that you might have been mistaken and depart, one small step for you, one giant leap for patientkind. Should this happen to your dentist three or four times a week, you can rest assured he or she will not be the abusive authority figure with whom you formerly dealt."

An excerpt from chapter six, "The Eyes Have It," is even more devastating to the savoir-faire of the dentist, leading one to believe that Buchanan must have been sorely abused at some time in his dental history to have stooped this low.

A study done by the psychology department of Duke University in the early '60s, confides Buchanan, revealed that the one thing dentists found most unnerving was eye contact with the patient while they were operating.

"So here's what you do," he says. "Instead of closing your eyes or staring around the hands in front of your face to study the ceiling tiles, look straight into the doctor's eyes. Register fear, loathing, unnatural attraction — anything you want. Just don't lose eye contact. The doctor will ignore this as long as he is able, which is about 45 seconds and then as you stare him down, he begins to unravel. Within five minutes of this, he will have lost it completely and is reduced to whimpering piteously in the lab."

The results of the Duke study were never made public, asserts Buchanan, because of intense pressure put on the university by powerful dental interests, both commercial and academic. Dentists universally have long acknowledged the validity of the study and have feared for years that sooner or later the truth would come out, and, their lives, no bed of roses even at this juncture, would become a living hell henceforth.

Organized dentistry, meeting secretly in Chicago, is said to have voted to fund a complete buyout of every existing copy of *Retribution; How Sweet It Is!* and to go as high as $3.5 million for the exclusive rights to the book. Should this attempt to silence Buchanan fail, a major dental school is rumored to be ready to offer him an honorary DDS degree and a tenured post as professor of patient relations if he will promise to publish no more.

My only hope is that if we can survive *60 Minutes,* OSHA, the FTC and the FDA, we can probably weather Buchanan too; but if somebody is going to pass the hat to finance a contract, count me in. ■■■■

CDA JOURNAL, VOL 39, Nº4

Sweet Vengeance Is Like Ice Cream: Best Served Cold

It seems that Wilfred Buchanan, probably a nom de plume to avoid having a contract put out on him like Salman Rushdie, has a beef against the dental profession.

Robert E. Horseman, DDS

ILLUSTRATION BY DAN HUBIG

Wilfred Buchanan has written a book. Ordinarily this would not have attracted my attention, which has been diverted since the acquisition of my first television set in 1948. The last book I recall reading before the numbness set in had a very complicated plot involving a lot of running and fetching centered around its three main characters, Dick, Jane and Spot. For the life of me, I can't remember how this all turned out except for some vague recollection that Spot was ultimately impounded for violation of the leash laws and Dick opened a live bait shop in Port Aransas. With the introduction of a 12-inch black-and-white extravaganza into my life, literary enhancement took a back seat.

An alert patient recently informed me that to be au courant I simply *must* get a copy of Buchanan's book, *Retribution: How Sweet It Is!*, because it concerns the sanity of every dentist now in practice. Realizing that my grasp on reality, virtual or real, is tenuous at best, I persuaded the folks at Crown Books to part with one of their 1,800 copies and I'm here to tell you that we're in big trouble.

It seems that Wilfred Buchanan, probably a nom de plume to avoid having a contract put out on him like Salman Rushdie, has a beef against the dental profession. Not that this is all that uncommon, but unlike ordinary patients who suffer their assorted discomfitures benignly, he has taken it upon himself to instruct them how to retaliate in kind without actually having any physical

CONTINUES ON 277

When you want your practice sale done right.

BetteRobin, DDS, JD

DENTIST ATTORNEY BROKER

Loma Linda Dental 83 Southwestern Law 95

Select Practice Services, Inc.
Dental Practice Sales and Transitions
877.377.6246 • www.BetteRobin.com
17482 Irvine Blvd., Ste E • Tustin, CA 92780

Opalescence® BOOST

Professional, in-office whitening in less than an hour—no light needed.

ULTRADENT PRODUCTS, INC
Improving Oral Health Globally

WHITEN

www.ultradent.com | 800.552.5512