OF THE CALIFORNIA DENTAL ASSOCIATION

Journal

JANUARY 2010

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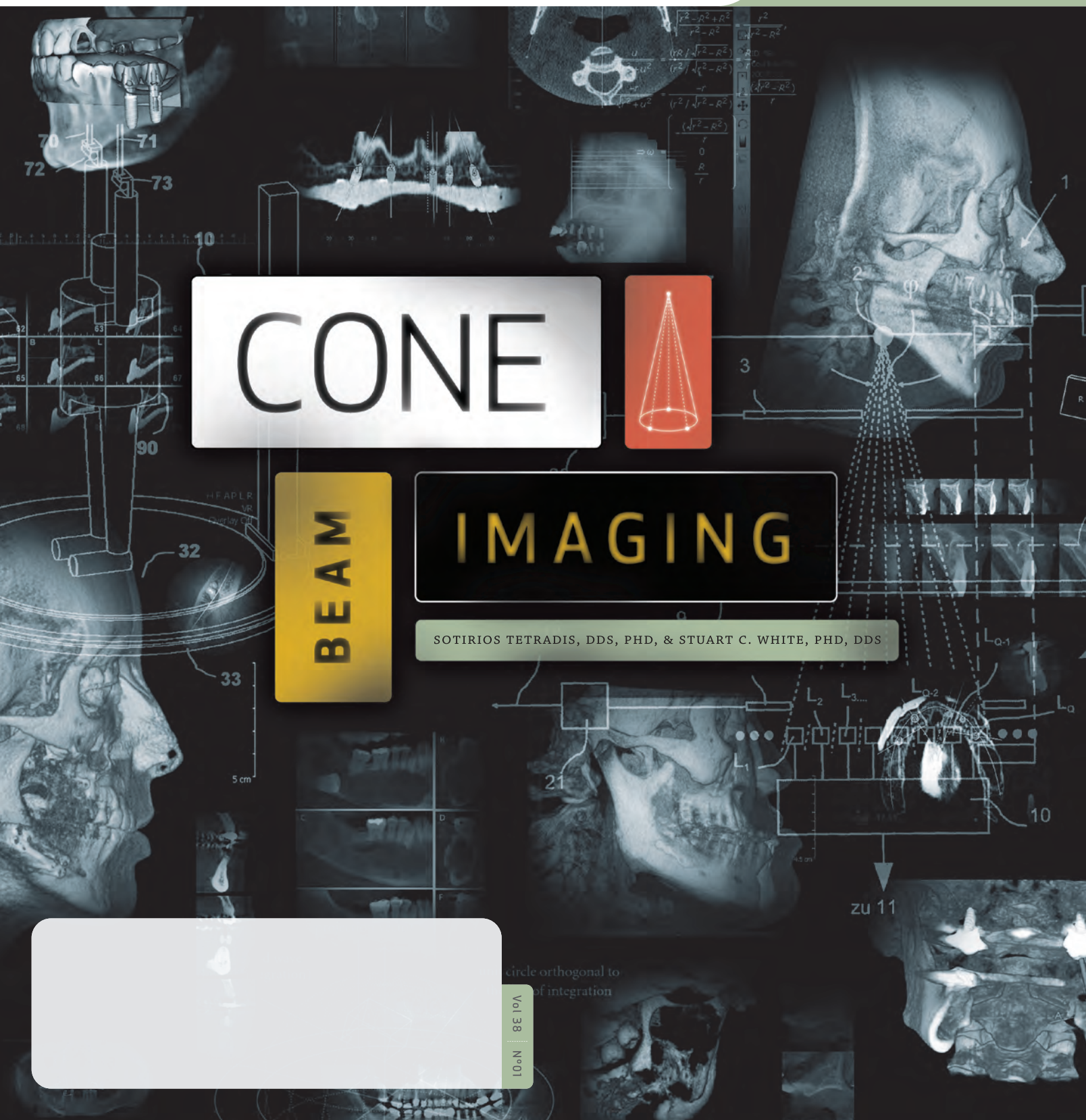

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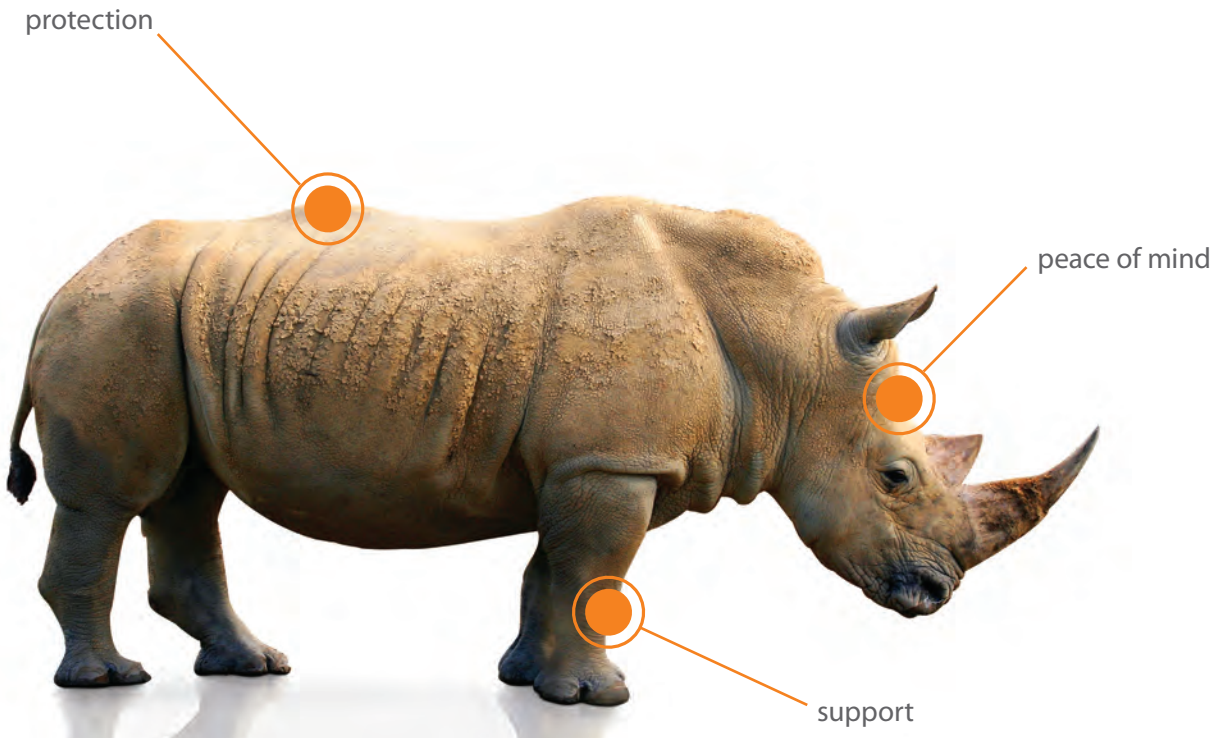
Vol 38 No01



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Journal

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MARCH: *General Topics*
APRIL: *Periodontics*

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CDA JOURNAL, VOL 38, Nº1

Righteous Indignation

KERRY K. CARNEY, DDS

I happened on some old papers and got caught up in reading about a moment in CDA history. It involved an episode of righteous indignation that escalated to the point of personal destruction. I am not going to give any particulars because those are not germane. It was the unfolding pattern that struck me: the inevitable self-immolation in the flames of righteous indignation.

Does righteous indignation ever have a positive result? It is certainly not conducive to consensus building.

Does righteous indignation ever have a positive result? It is certainly not conducive to consensus building. Once an issue is framed in such a manner, it can only lead to a hardening of feelings. The emotional companions of righteous indignation are disgust, contempt, and perceived insult. It is easy to dismiss ideas in conflict with our own once that pilot light of righteous indignation has been lit. However, the resulting immolation can destroy careers, friendships, and organizations.

Working with people is difficult. People are puzzling. However, life is about working with people and in dentistry that is especially so. As dentists, we have to work with people on many levels and in various roles. Take the relationships we enjoy with our patients: Are they our friends, our market share, our customers, our partners in health care? The doctor/patient model has been analyzed employing all these perspectives and more. As dentists, we also interact with our colleagues both as part of patient care and as members of organized dentistry. It was in this latter context that the event under consideration occurred.

The first time I applied for a volunteer position at CDA, the application seemed a bit off-putting. I completed the sections on academic accomplishments, and I had been active in our local component. But when I came to the section on community activities, I had zero to report. I had been working six days a week trying to grow a new practice and had not reached out and connected with the community activities and local volunteer organizations.

It was CDA leadership training and experience that helped me become more involved in my community. One of the greatest advantages afforded by experience in the volunteer positions at CDA is a better understanding of leadership qualities and responsibilities. Each volunteer has the opportunity to learn how to "play well with others." By that, I mean you can learn to work successfully with other people toward a common goal.

We have all been on at least one board or committee of some organization that was dysfunctional. People bring a portfolio of psychological baggage with them to every meeting. They can wear you down and steal precious minutes of your life with their enervating negativity. But when a group works well together, it is energizing and gives you the desire to achieve even more. In a well-functioning group, the members develop mutual trust and know they can rely on one another to take care of their own duties and find opportunities to facilitate the work of others.

I am a subscriber to the "Our Gang/Little Rascals" theory of group dynamics. "Our Gang" was a series of short movies made between 1922 and 1944. The kids in "Our Gang" predated organized sports and activities. For entertainment, they were left pretty much up to their own devices. But whenever they decided to do something, like stage a play, everyone worked with single-minded devotion toward achieving that goal. Instead of the negative reception given to new ideas in a dysfunctional group, the kids in "Our Gang" saw each idea as a springboard for other ideas. Before the end of the movie, they would have everything they needed for their performance. It is this very creative and cooperative spirit that makes working on a project with others fun.

My involvement with CDA and ADA has taught me two important lessons. First, not every good idea will be recognized and embraced immediately. Second, not every new idea is good. It takes evidence, logic, context, time, and opportunity for people to subscribe to new, good ideas. It takes cooperation, trust, and hard work to build a well-functioning organization.

Transparency of information, clarity of function, openness to differing opinions, unity of purpose, and effectiveness of action are the hallmarks of a well-functioning organization. The process of keeping any organization healthy and relevant is ongoing and continually needs attention. But righteous indignation is a distraction that leads to nothing positive. The next time I feel that pilot light ignite, I think I will just take a walk and get some perspective. Bonfires of righteous indignation have a way of becoming pyres of the best intentions. ■■■■

Address comments, letters, and questions to the editor to kerry.carney@cda.org.

CDA JOURNAL, VOL 38, Nº1

Reader Disappointed in Pediatric Issue

The articles in the October 2009 issue of the *Journal of the California Dental Association* "Good, Clinical Pain Practice for Pediatric Procedure Pain: Target Considerations" (pages 719-722) and "Good, Clinical Pain Practice for Pediatric Procedure Pain: Iatrogenic Considerations" (pages 713-718), by Dennis Nutter, DDS, were very disappointing. I am a board-certified pediatric dentist and I found both pieces offensive.

There are numerous statements made that are not supported by references. These all should be interpreted as options and not supported facts.

The author contradicted himself when he pointed out in "Iatrogenic Considerations" that "there does not yet exist reliable, objective, measure of pediatric pain." Yet, in "Target Considerations" he stated, "When pain is a possibility, it should be measured."

He complained about the use of restraints, voice control, and hand over mouth. Hand over mouth has been out of use for a number of years. The use of restraints is slowly falling to the wayside as pediatric dentists are using sedation methods more. I find it interesting that I have read complaints in the *Journal of the American Academy of Pediatric Dentistry* that pediatric dentists have gotten away from behavior management methods and depend on pharmaceutical methods more. The author quoted a paper citing a very low number of pediatric dentists using sedation methods, yet everyone I know of uses nitrous oxide/oxygen on a daily basis. For the more uncooperative children, they use oral sedation and/or intravenous sedation administered by an anesthesiologist. These two methods can be quite stressful, but there are children who are untreatable with less invasive methods.

Which brings up another point. What about those patients who enter your office screaming and crying for their first dental appointment anywhere? Did their parent's car inflict pediatric pain? The parking lot? A good rule of thumb is, if the patient can sit for a haircut then he/she will sit for a dental exam. I have had numerous patients cry because they are scared then tell me they did not feel a thing when they were done.

The author quoted a 1994 study where "11 percent of practicing Seattle-area dentists strongly agreed with denying the pain reports of children." This means that 89 percent did not agree. He went on to say "and a large majority of the dentists in the study doubted that authenticity of children's behavioral pain reports issuing during invasive procedures." What was the percentage for this statement? A large majority can be interpreted numerous ways, 51 percent or 90 percent, depending on the individual.

Let's be realistic. Some children cry for dental procedures, no matter what the dentist does. Just like there are adults who complain of everything a dentist may do. I am sure there is a percentage of children who do experience pain, but most will tell you versus becoming unruly. Good communication is very important when treating children.

ROBERT RIPLEY, DDS
Yuba City, Calif.

Dr. Nutter Responds

The focus of Dr. Ripley's letter is a rejection of the first principle of good clinical pain practice that compels clinicians to treat a child's pain reports as credible under conditions of tissue trauma or as clinical pain authority Patricia McGrath put it, "that only the child can know how much pain they are experiencing." This is not a point that I will concede. How much pain a clinician chooses to justify hinges on who is deciding that question — the clinician or the child. I have amply documented my reasons for agreeing with Patricia McGrath, Donald Price, and others that it is the child who must decide how much pain they are experiencing.

The writer's confusion about pain measurement is understandable given the scant training that most dental clinicians receive in this area. Clinician estimations of pain intensity are influenced by subjective bias and the patient's own pain reports are themselves reflections of the subjective nature of pain. This subject deserves further study in greater detail.

The writer contends that since the 1994 Milgrom and Weinstein et al. study found that "11 percent of practicing Seattle-area dentists strongly agree with denying the pain reports of children," then "this means that 89 percent did not agree." Not exactly. This question item was paired with a seven-point Likert scale to give respondents a means to specify their level of agreement with the

statement. Ten percent of the respondents strongly disagreed with denying a child's pain report while, on the other end of the spectrum, 11 percent strongly agreed. Each of the five-scale points in between represent an area that I have interpreted as indicating some degree of "doubt." Hence, my statement regarding the number of dentists who "doubted the authenticity of children's behavioral pain reports issuing during invasive procedures" referenced a "large majority."

During invasive treatment, clinicians cannot know if a child's pain reports are authentic. If we guess wrong and disbelieve their pain reports, besides causing suffering and distrust, we may also harm the child with a sensitization injury that can debilitate their reactions to future necessary medical treatments. Therefore, we must derive our treatment strategies as if they are credible. Clinicians must tread cautiously when deriving treatment strategies for those children who "cry for dental procedures no matter what the dentist does." Good clinical, pediatric pain practice requires that the assessment intervention dynamics of dentists treating children be oriented toward pain, not behavior. Measuring pain will allow clinicians to develop and improve upon intervention strategies that are effective in controlling pain in all of its dimensions.

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CDA JOURNAL, VOL 38, Nº1

Thank You to the *Journal* Reviewers

Authors have their names on their articles. Contributing editors, staff members, and outside vendors have their names in the masthead. But there are more people involved in putting out the *Journal* than those whose names are printed in each issue. There are also the professionals who formally review manuscripts and offer their recommendations. Below is a list of the people whose reward comes in the form of a thank you letter and a listing here. In addition, there are many others who have provided information counsel to the *Journal*. It is impossible to list them all. The *Journal* extends its thanks to the following people and everyone else who assists us in our endeavor.

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Screw-ups

BY DAVID W. CHAMBERS, PHD

Every dental office is well-stocked with a supply of screw-ups. We teach students to distinguish between those that are unavoidable by a competent and well-motivated dentist (called "bad outcomes") and those that reasonably could have been avoided (called "bad work"). Peer-review committees, lawyers, and malpractice carriers make such distinctions; patients not so much.

The overriding rule, the essence of the American Dental Association's Ethics Code, is that patients must be made aware of their oral conditions. This is a requirement for describing the condition and explaining its significance. The matter of accepting responsibility, justifying what has been done, or otherwise owning the problem is a separate matter.

CONTINUES ON 13

Transcendentist Inc.

Transcendentist Inc. is proud to announce the official launch of its green dental products and services for dental professionals. The company's initial offering includes a uniquely designed, reusable, cloth dental operatory line of headrest covers, patient bibs, and light handle covers designed to reduce waste and save money. Transcendentist is also introducing an all natural aromatherapy line created especially for the dental office, Joysence, which includes a CDC-compliant hand-sanitizer containing organic alcohol, as well as a scented lotion, hand soap and room and hot towel spritz. For more information go to transcendentist.com.

Another Way to Go Green

For the ever-increasing number of physicians wanting to offer patient payment plans to finance health care and to go green, online payments may be the way to go.

ePatientPayments.com is simple and cost-effective, with options for custom patient recurring payment plans, or simple pay-on-account functionality. ePatientPayments allows staff to quickly generate a custom plan for every patient and e-mail a URL link to patients for easy online payment. Its easy admin control panel allows staff to monitor income received from recurring payment plans or "pay-on-account" payments entered by the patient. With PayPal handling all sensitive customer information, practices do not need to worry about storing credit card numbers or how to set up a secure Web site, according to a ePatientPayments.com press release.

Javelin Strategy & Research said if every home in America viewed and paid its bills online, it would cut solid waste by 1.6 billion tons a year and curb greenhouse-gas emissions by 2.1 million tons a year.

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"We found that the abilities of those aged 50 to 59 with pain were far more comparable to subjects aged 80 to 89 without pain."

KENNETH COVINSKY, MD, MPH

Pain May Speed Signs of Aging Significantly

Fifty looking 30 is great. Fifty looking 80, not so much. (Cue Edvard Munch's "The Scream.") But, according to a study in a recent issue of the *Journal of the American Geriatric Society*, young people in pain look the same as their elders who are pain-free.

Researchers pored over data from the 2004 Health and Retirement Study in which there were 18,531 participants age 50 and older. It was posited that functional restrictions that weaken the ability to live independently increase significantly as one ages. Mobility, i.e., jogging or walking; upper extremity tasks; climbing stairs; and daily self-care such as eating, dressing, bathing with or without help, were examined.

The results: People living with pain develop at a much earlier age the functional limitations that generally are associated with aging. According to a press release, 24 percent of participants had significant pain (often troubled by pain that was moderate or severe most of the time) and across all four physical abilities studied, participants with pain had much higher rates of functional limitations than subjects without pain. In the mobility function as an example, of subjects aged 50 to 59 without pain, 37 percent were able to jog one mile and 91 percent were able to walk several blocks without difficulty, compared to those in pain with 9 percent and 50 percent, respectively.

"We found that the abilities of those aged 50 to 59 with pain were far more comparable to subjects aged 80 to 89 without pain, of whom 4 percent were able to jog one mile and 55 percent were able to walk several blocks, making pain sufferers appear 20 to 30 years older than nonpain sufferers," said Kenneth Covinsky, MD, MPH, of the Division of Geriatrics at University of California, San Francisco, who led the study. "After adjustment for demographic characteristics, socioeconomic status, comorbid conditions, depression, obesity, and health habits, across all four measures, participants with significant pain were at much higher risk for having functional limitations."

Caries Risk Is Higher in Cleft Lip/Palate Patients

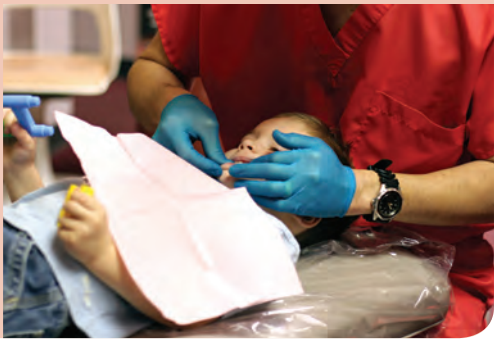
Those with cleft lip and/or palate are nearly twice at risk for exhibiting a moderate or high dental caries score than their siblings who do not have the facial condition.

In a study, recently published in *The Cleft Palate-Craniofacial Journal*, researchers at Damascus University of Syria compared 53 patients with clefts aged 12 to 29 years with 53 sex- and age-matched siblings without clefts. All of the 106 study participants had the same dental examination without X-rays.

The dental caries scores were computed according to decayed, missing, and filled permanent teeth. Of the 53 patients with clefts, 85 percent exhibited a moderate or high dental caries score while of the 53 control subjects, 43 percent scored similarly.

According to the study author, "independent of socioeconomic status, cleft patients are more susceptible to dental caries, and therefore 'the implementation of special dental caries preventive programs should be encouraged in approaching cleft lip and/or palate patients.'"

To read the entire article, "Comparison of Dental Caries Prevalence in Patients With Cleft Lip and/or Palate and Their Sibling Controls," go to www2.allenpress.com/pdf/cpcj-46-05-529-531.pdf.



Podcasts Entertain, Inform Public on Oral Health

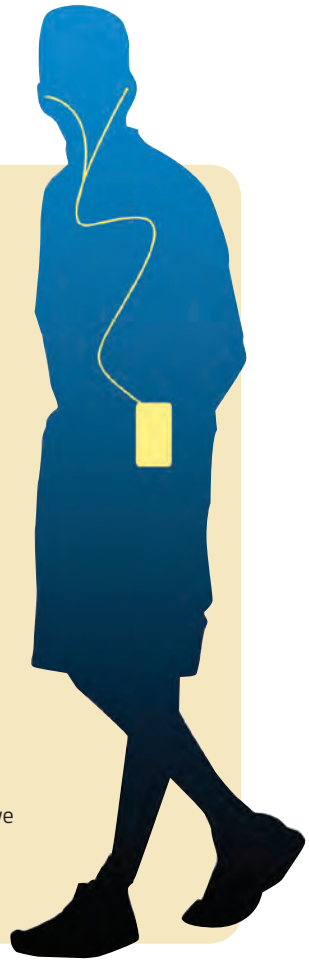
Are your patients wondering about tooth whitening, how to overcome dental fears, or dental care while in other countries? Then tell them to stay tuned each month, or rather, iTunes in.

The American Dental Association recently launched a video podcast, *Straight from the Mouth*, that provides three- to five-minute Webisodes that are fun and educational. In addition to being available on iTunes, the podcasts are featured on ADA's Web site, ada.org.

Topics range from dental care for kids, oral health care while traveling around the globe, tooth whitening and not letting dental fear get the best of them.

"We're having a lot of fun with these, but at the heart of each episode is sound clinical and scientific information to help people maintain their oral health," said Ruchi K. Sahota, DDS, a practicing dentist in Fremont, Calif., who cohosts the show with recent Loma Linda University School of Dentistry graduate Eric Grove, DDS.

"Movies and TV shows make fun of dental anxiety," Grove said of the first episode that covered dental anxiety. "But people who suffer from it also can suffer the consequences of neglecting their teeth and gums, and that's no joke. In our podcast, we joke around a little, but we also offer practical tips to help people overcome anxiety. Regular dental care is important, and dentists want to make their patients' visits as comfortable as possible."



SCREW-UPS, CONTINUED FROM 11

Reports are beginning to appear in the medical literature that lawsuits can be reduced in frequency and in cost when physicians acknowledge and express regret over unwelcome outcomes, regardless of fault.

The major categories of response to unwelcome outcomes include expression of regret, apology, excuses and justification, offers of reparation, diagnosis and explanation, encouragement or acceptance of legal remedies, arbitration, promise making, and bluffing, or doing nothing. The question is, which ones work best in which situations? If the unwelcome outcome is an unforeseeable result, despite good intentions and good procedures or if it is a result discussed in informed consent chosen by the patient, expression of regret, denial of responsibility, diagnosis and explanation, and perhaps promising to work out a new approach, are good strategies.

If the unwelcome outcome is a result of negligence, poor skill, misjudgment, or other form of isolated incompetence in the eyes of the patient, the correct response is expression of regret, diagnosis and communication, offers of reparation, and above all, an apology. An apology involves the twin components of regret and acceptance of responsibility. The goal in this situation is to repair the level of trust between the dentist and patient. Legal or arbitration responses will not do this. Engaging the patient in diagnosing, even tentatively what is at stake in correcting the problem, is an excellent strategy. Research has shown that positive gestures are magnified where the concern is competence.

The opposite happens when the patient perceives that the issue is the dentist's integrity: cutting corners, lack of informed consent, overtreating, etc. In such situations, negative information is weighed excessively. Dentists should not apologize but should consider denial of responsibility, excuses and justification, and legal settlement. I am not so much offering advice for bad actors to beat the rap as altering those who make the occasional, well-intended misstep that patients will interpret the strategies of the dentist with poor motives as evidence that the dentist lacks integrity.

The nub:

1. Never let another dentist be the first to tell a patient that there was an unwelcome event in their mouth.
2. Explain and offer to help when unwelcome outcomes occurred by chance.
3. Apologize if it is reasonable for the patient to believe that the unwelcome even was caused by a slip of competence.

David W. Chambers, PhD, is professor of dental education, Arthur A. Dugoni School of Dentistry, San Francisco, and editor of the Journal of the American College of Dentists.

Flavors range from mint to chocolate, making them appealing to youths who can purchase them online and in malls.

Toxins Detected in E-cigarettes, FDA Issues Alert

Recently, the Food and Drug Administration informed patients and those working in the health care fields that toxic chemicals and carcinogens have been found in electronic cigarette samples, following laboratory analysis.

These cigarettes, which also go by the moniker of "e-cigarettes," are battery-operated and typically contain cartridges filled with nicotine, flavor, and other chemicals such as diethylene glycol, which is found in antifreeze. E-cigarettes turns the highly addictive nicotine and other chemicals into a vapor that then the user inhales. Flavors range from mint to chocolate, making them appealing to youths who can purchase them online and in malls.

Analyzing the ingredients in a small sample of cartridges from two major electronic cigarette brands, the FDA's Division of Pharmaceutical Analysis found diethylene glycol as well as other carcinogenics such as nitrosamines.

These products don't carry health warnings that are found on traditional nicotine alternatives or regular cigarettes. Additionally, since e-cigarettes have not been submitted to the FDA for approval or evaluation, the agency does not know, (with the exception from its limited testing), how much nicotine or what kind of other chemicals are consumed by the user.

To report side effects or product quality issues stemming from e-cigarette use, contact the FDA's MedWatch Adverse Event Reporting program via online at https://www.accessdata.fda.gov/scripts/medwatch/medwatch-online.htm or call 800-FDA-1088.

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UPCOMING MEETINGS

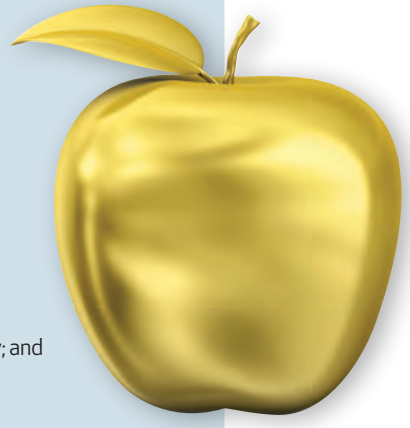
2010	
April 11–17	United States Dental Tennis Association, Amelia Island Plantation, Fla., dentaltennis.org.
April 26–28	National Oral Health Conference, St. Louis, Mo., nationaloralhealthconference.com.
May 13–16	*CDA Presents The Art and Science of Dentistry*, Anaheim, 800-CDA-SMILE (232-7645), cda.org.
Sept. 9–11	*CDA Presents The Art and Science of Dentistry*, San Francisco, 800-CDA-SMILE (232-7645), cda.org.
Nov. 7–13	United States Dental Tennis Association, Grand Wailea, Hawaii, dentaltennis.org.
2011	
May 12-15	*CDA Presents* the Art and Science of Dentistry, Anaheim, 800-CDA-SMILE (232-7645), cda.org.
Sept. 22-24	*CDA Presents* the Art and Science of Dentistry, San Francisco, 800-CDA-SMILE (232-7645), cda.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.

State and Local Dental Societies Honored for Outreach Programs

The California Dental Association received a Golden Apple for its "CDA Leadership Education Conference and Regional Training" in the category of "Excellence in Member-Related Services/Benefits" from the American Dental Association.

The award was given to the CDA for a dental society with total membership of more than 1,000 dentists. Now in its 21st year, the Golden Apple Awards program recognizes noteworthy achievement in dental society activities and excellence in leadership.



Also receiving Golden Apples:

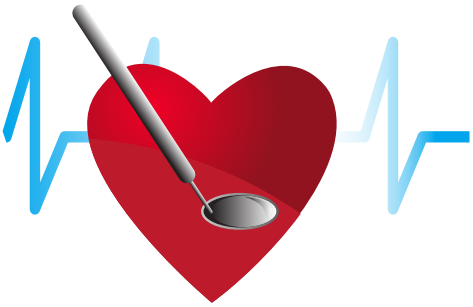
- West Virginia Dental Association for Legislative Achievement in the constituent society category with a total membership of fewer than 1,000 dentists;
- Indiana Dental Association for a constituent society with total membership of more than 1,000 dentists;
- Maryland State Dental Association for membership recruitment;
- Livingston District (Michigan) Dental Society, "Excellence in Dental Health Promotion to the Public," component category;
- North Carolina Dental Society, "NC Missions of Mercy Public Awareness," constituent category; and
- New York State Dental Association for "Outstanding Achievement in the Promotion of Dental Ethics."

Additionally, Richard G. Stevenson, III, DDS, of the University of California, Los Angeles, School of Dentistry, was recognized with the Inspiring Careers in Dental Education Award, predoctoral level category.

Dentists Can Identify Heart Risk Patients, Study Says

An analysis has concluded that oral health professionals are in a position to identify patients who may be unaware of their risk of death as a result from cardiovascular disease and who need medical intervention.

In the study, Swedish dentists used a computerized system, HeartScore, to track 200 patients in various private dental practices. HeartScore calculated the possibility of the patient dying, within a 10-year time frame, from a heart-related event. The computer system, designed by the European Society of Cardiology, measures cardiovascular disease risk in individuals between the ages of 40 to 65, factoring in the person's gender, gender, smoking habits, total cholesterol level, and systolic blood pressure, according to the article published in the November 2009 issue of the *Journal of the American Dental Association*.



Those individuals with HeartScores that indicated they had a 10 percent or more risk of experiencing a fatal heart attack or stroke within a 10-year period, were encouraged by the dentists to seek medical advice. Twelve of the 99 men in the study, had HeartScores of 10 percent or higher; all of the 101 females in the study had HeartScores of 5 percent or less.

Of those 12 men with HeartScores of 10 percent or higher, only nine sought further evaluation. Of those nine, intervention was indicated for six of the patients. Two patients did not follow the dentist's recommendation to seek further medical evaluation; one patient was only encouraged by his dentist to discontinue smoking, according to a press release. The physicians for three patients were not able to confirm their risk for cardiovascular disease.

"With emerging data suggesting an association between oral and nonoral diseases, and with the possibility of performing chairside screening tests for diseases such as cardiovascular disease and diabetes, oral health care professionals may find themselves in an opportune position to enhance the overall health and well-being of their patients," the authors said.

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Matt Mullin

Aggressive Toothbrushing Tops the List of Causing Sensitive Teeth

In a nationwide member survey conducted by the Academy of General Dentistry, one in three dentists said aggressive toothbrushing is the most common cause of dentin hypersensitivity. Earning second place was consuming acidic drinks and food.

An estimated 40 million Americans of all ages suffer from dentin hypersensitivity, which is characterized by sudden and sharp pain in one or more teeth and often is set off by cold or hot, sour or sweet drinks and foods, inhaling cold air, and pressure on the affected tooth.

The combination of a aggressive toothbrushing and consuming acidic foods and beverages can lead to tooth sensitivity, said Van B. Haywood, DMD, because these factors can wear down tooth enamel and affect one's gums.

Other contributing factors included specific mouthwashes and toothpastes, tooth whiteners, cracked or broken teeth, acid reflux and even bulimia.

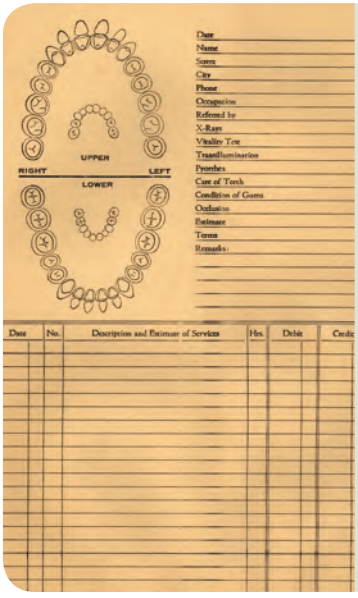
Of the 700 general dentists surveyed, 60 percent responded that they have noticed a rise in tooth erosion, compared to five years ago.

"Being able to detect tooth erosion in its early stages is perhaps the most important key to preventing dentin hypersensitivity," said Raymond K. Martin, DDS, MAGD. "Discoloration, transparency, and small dents or cracks in the teeth are all signs of tooth erosion and should be discussed with your dentist as soon as possible."

Nearly 60 percent of the dentists who participated in the survey said patients avoid cold drinks and food in an effort to manage their tooth sensitivity. Another 17 percent, according to a press release, said that patients avoid brushing the sensitive area of the mouth. "While these may seem like the quickest and easiest ways to prevent sensitivity, none of them will actually solve the problem," said Gigi Meinecke, DMD, FAGD.

For those already suffering from sensitive teeth, the AGD recommended:

- switching to a toothpaste made especially for sensitive teeth,
- using a soft-bristled toothbrush,
- flossing regularly and brushing at least twice a day
- avoiding highly acidic foods and beverages.



New Resource Available for Complying With HIPAA Breach Rule

A downloadable electronic book, courtesy of the American Dental Association, now is available to assist dental offices in complying with the improved security breach and privacy rules as they relate to the American Recovery and Reinvestment Act.

Although HIPAA requirements in maintaining privacy of patient health records has not changed, the procedure that providers must take in case of a security breach has changed. Additionally, there now are significant fines for noncompliance.

Utilizing a Q&A format, the book can help dental offices understand and prepare for compliance. Topics range from "A Breach Notification Flow Chart" and "Sample Breach Notification Policy and Procedures' to "Sample Breach Notification Risk Assessment Worksheet" and "Sample Breach Notification Notice to Individual."

"Guidance for Complying with the HIPAA Breach Notification Rule" is available as a downloadable e-book free to ADA members. The book also is available for $99 to non-ADA members.

CDA PRESENTS

SHOW HIGHLIGHTS

ANA10

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The Art and Science of Dentistry in the Heart and Soul of Southern California

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HARALD O. HEYMANN, DDS, MED

Dental Materials

Bread-and-Butter Adhesive and Restorative Dentistry	Saturday morning lecture

TERRY DONOVAN, DDS

Dental Materials/Restorative

Update in Esthetic Restorative Dentistry	Saturday morning lecture
Restoration of the Worn Dentition	Sunday lecture

KENNETH M. HARGREAVES, DDS, PHD

Endodontics

Managing the Endodontic Infection	Friday morning lecture
Regenerative Endodontics	Friday afternoon lecture
Successful Management of Acute Dental Pain	Saturday morning lecture
How to Successfully Anesthetize the "Hot" Tooth	Saturday afternoon lecture

TRICIA OSUNA, RDH, BS, FAADH

Ergonomics

Save Me — Save You! Ergonomics and Effective Patient Care	Thursday morning and Saturday afternoon lectures
What Is It? How Do I Use It? Today's Dental Products and Treatment Options	Thursday afternoon and Saturday morning lectures

THOMAS J. MCGARRY, BS, DDS, FACP, FACD

Prosthodontics/Removable

Implant Dentistry in Everyday Practice — Placement to Restoration	Friday lecture

BRIAN P. LESAGE, DDS, FAACD; EDWARD A. MCLAREN, DDS, MDC

Esthetic Dentistry


Two-Day Continuum Workshop Anaheim and San Francisco	Friday and Saturday two-day workshop

GEORGE F. PRIEST, DMD

Esthetic Dentistry

Soft Tissue Development With Provisional and Definitive Implant Restorations	Thursday morning lecture
Progressive Veneer Techniques for Optimal Esthetics	Thursday afternoon lecture
Implant Rehabilitation of Edentulous Maxillae	Friday morning lecture
A Collaborative Approach to Esthetic Outcomes in Young Patients	Friday afternoon lecture

HARALD O. HEYMANN, DDS, MED (MODERATOR); THOMAS F. BASTA, DDS; TERRY DONOVAN, DDS; MARK J. FRIEDMAN, DDS; RICHARD SIMONSEN, DDS

Failures in Dentstry Panel





Ethical Controversies in Esthetic and Restorative Dentistry	Saturday afternoon panel

TERRY TANAKA, DDS

TMD

The New Quarterback: A New 2010 Treatment Planning Playbook for the General Dentist	Friday lecture
TMD Management in 2010: Science or Smoke and Mirrors?	Saturday morning lecture
Splint Therapy: What Works, What Doesn't and Why	Saturday afternoon lecture

REQUIRED COURSES

California Dental Practice Act and Infection Control — Ticketed Admission Only

The Dental Board of California mandates continuing education in infection control and the California Dental Practice Act. Every renewal cycle, California law requires licensed dentists and specified allied dental health professionals to complete 2 units in infection control and 2 units in the California Dental Practice Act in Category I. CDA is proud to present the following courses that will fulfill these required units for license renewal.

Please note:

- Admission to these C.E. courses will be by ticket only.
- Seating is limited. Tickets will be sold on a first-come, first-served basis.
- You may purchase your ticket in advance by completing the registration form on Page 15 or registering online. Tickets are $20 and will guarantee your seat in the course.
- If available, tickets will also be sold on-site at the Ticket Booth located in the registration area of the Anaheim Convention Center.
- There will be no late entries allowed. The California mandatory education requires 2 full hours for credit. It is strongly recommended that you arrive a minimum of 15 minutes in advance of the published starting time.
- Licensees are only required to attend one class on the California Dental Practice Act and one class on infection control each renewal period.

Infection Control for California

Dental Board requirement for 2 units: This program provides you with the latest educational requirements specific to CCR section 1005, the Dental Board of California Infection Control Regulations, to include handwashing techniques, sterilization and disinfection protocols. Also discussed will be the Cal-OSHA bloodborne pathogen standard, California Department of Health services waste management and CDC/ADA recommendations. Note: The 2-hour course does not meet the new Infection Control education requirement for unlicensed dental assistants.

California Dental Practice Act

Dental Board requirement for 2 units: This seminar meets the new C.E. requirement for California Dental Practice Act education, including the new one-time course requirement for unlicensed dental assistants. It discusses information and updates to the Dental Practice Act regulations on scope of practice, acts in violation of the Dental Practice Act and attending regulations, and other statutory mandates relating to the dental practice. This includes utilization and scope of practice for auxiliaries; scope of practice for dentists; laws governing the prescribing of drugs; citations, fines, revocation and suspension; and license renewal.

New Educational Requirements for Unlicensed Dental Assistants and Other Office Personnel

Beginning January 2010, dental assistants or any other individual in the dental office performing any of the duties of a dental assistant will have a ONE-TIME only educational requirement to complete the existing 2-hour California Dental Practice Act course and a new 8-hour comprehensive Infection Control course. Additionally, they will be required to maintain a current, basic life support certificate. CDA is currently working with the Dental Board of California to clarify questions in order to implement the new Infection Control course requirement. It is CDA's plan to have tools available for local dental societies and individual CDA members who may wish to become providers of the 8-hour Infection Control course.

Note: The 2-hour infection control course required of all licensed personnel (dentists, registered dental hygienists and registered dental assistants) for licensure renewal does not meet infection control requirement.

Prepaid Early Bird Parking

To make your parking experience easier, CDA is offering the opportunity to purchase parking at the Anaheim Convention Center in advance. If you arrive by 8 a.m., this will guarantee a parking space with the added convenience of not worrying about having cash on hand. Purchase the tickets along with your registration.

The following conditions apply:

- Tickets are $12 per day and are available for Thursday, Friday, Saturday and Sunday.
- Arrive by 8 a.m. — prepaid parking spaces will not be honored after that time.
- Parking passes are nonrefundable. Refunds cannot be given for lost or forgotten passes.
- Original passes must be used.
- Passes must be surrendered upon entry to the lot.
- Passes are only valid at the Anaheim Convention Center. They cannot be used at off-site parking or Disney lots.

Traffic and Parking Recommendations

If you are driving to the Convention Center, traffic is anticipated to be heaviest on Friday morning. To minimize any inconvenience, **early arrival is strongly recommended.** The peak traffic and parking time is projected to be from 8 to 11 a.m. Please watch the traffic control signs as you exit the freeway for the most updated parking information. Early arrival is also recommended for Saturday.

Off-Site Parking

CDA is working to secure off-site parking near the freeway exits with complimentary shuttle service to the Anaheim Convention Center. Due to scheduling of events at these venues, this can only be confirmed within a few weeks of our meeting. Please watch for additional information in your badge mailing, attendee e-mails or visit us at cdapresents.com for updated instructions the week prior to the meeting.

Prepaid Food Vouchers

Treat your staff to lunch with vouchers for the Anaheim Convention Center concession areas. Available in increments of $10, vouchers allow a prepaid, hassle-free option to grab something quick or sit down and enjoy a meal with your team while attending the exhibit hall or between C.E. courses. Menu options include specialty coffee and breakfast items, Grab 'n' Go for lunch, Mexican taqueria, made-to-order sandwiches, All American Grill, barbecue, rice bowl and Freschetta pizza. Exact locations and food selections will be included in your registration packet and on cdapresents.com. These vouchers are nonrefundable and must be used for amount shown. Change cannot be given if purchase is less than $10.

Purchasing Vouchers

Purchase prepaid food and parking vouchers when you register online at cdapresents.com or by submitting the advance registration form.

PREPAID PARKING VOUCHER

Fee: $12

Event #: 057 Thursday
058 Friday
059 Saturday
060 Sunday

PREPAID FOOD VOUCHER

Fee: $10

Event #: 061

SPECIAL EVENTS

Disney's CALIFORNIA ADVENTURE PARK

CDA Night at *Disney's California Adventure®* Park

Enjoy an exclusive party for *CDA Presents* attendees and their guests! Your evening will be filled with special attractions, food and fun! Please check cdapresents.com for details.

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FRIDAY, MAY 14

7–9 p.m. Enjoy *Disney's California Adventure®* Park.
9 p.m. Park closes to the general public.
9–11 p.m. Disney attractions.
Fee: $65
Event #: 056

WineFUNdamentals Wine Party Reception

Enjoy learning about wine with interactive activities at each of our wine tables – learn to distinguish the various scents and flavors in wine, practice your new skills by tasting white varietals blind, explore red wine varietals from a particular area, discover new taste sensations tasting wines paired with both cheese and chocolate, and put your new wine knowledge to the test and win some prizes playing our wine trivia game!

SATURDAY, MAY 15

Time: 4–5:30 p.m.
Location: The Spot — Exhibit Hall D
Fee: $25
Event #: 062

DISNEYLAND TICKETS

Significantly discounted *Disneyland*® Resort theme park tickets are available to attendees during *CDA Presents*. These tickets will only be available for purchase online. These tickets are created just for you, and not all are available at the front gates of theme parks! Buy in advance and save! To purchase these tickets, please visit cdapresents.com. Please note that purchase of theme park tickets is separate from *CDA Presents* registration. Ticket store closes May 6, 2010 at 9 p.m. PST. **All tickets valid May 7-20, 2010.**

ONE DAY/ONE PARK	Admission to either *Disneyland*® Park or *Disney's California Adventure*® Park for one day.	Adult: $64 Child (3-9 years): $54
ONE-DAY PARK HOPPER®	Admission and ability to visit both *Disneyland*® Park and *Disney's California Adventure*® Park on the same day for one day.	Adult: $84 Child (3-9 years): $74
TWO-DAY PARK HOPPER®	Admission and ability to visit both *Disneyland*® Park and *Disney's California Adventure*® Park on the same day for two days.	Adult: $131 Child (3-9 years): $111
THREE-DAY PARK HOPPER®	Admission and ability to visit both *Disneyland*® Park and *Disney's California Adventure*® Park on the same day for three days.	Adult: $159 Child (3-9 years): $129
FOUR-DAY PARK HOPPER®	Admission and ability to visit both *Disneyland*® Park and *Disney's California Adventure*® Park on the same day for four days.	Adult: $169 Child (3-9 years): $139
FIVE-DAY PARK HOPPER®	Admission and ability to visit both *Disneyland*® Park and *Disney's California Adventure*® Park on the same day for five days. *Enjoy two free days of magic when you visit both Disney's California Adventure*™ Park and *Disneyland*® Park for *five days for the price of three!*	Adult: $174 Child (3-9 years): $144
TWILIGHT CONVENTION TICKET	An ideal admission option for after meetings or events! Admission is valid for one visit to either *Disneyland*® Park or *Disney's California Adventure*® Park after 4 p.m., or four hours before park closing, whichever is earlier, since park hours are subject to change. "Back and forth" privileges are not included.	Adult: $41

Tickets are printed on demand from your home computer. Purchase is separate from meeting registration.
NOTE: The special pricing on this page is available **only** with your advance, pre-arrival purchase. Box office tickets will be available at the *Disneyland*® Resort Main Gate Ticket Booths at **regular** prices. Prices subject to change.


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A Decade of Cone Beam Computed Tomography

SOTIRIOS TETRADIS, DDS, PHD, AND STUART C. WHITE, DDS, PHD

GUEST EDITORS

Sotirios Tetradis, DDS, PHD, is a professor and chair in the Section of Oral and Maxillofacial Radiology at the University of California, Los Angeles, School of Dentistry.

Stuart White, DDS, PHD, is professor emeritus in the Section of Oral and Maxillofacial Radiology at University of California, Los Angeles, School of Dentistry.

Cone beam computed tomography was introduced in oral and maxillofacial imaging a decade ago. It was recognized immediately that CBCT provided a paradigm shift in imaging the craniofacial complex. Utilizing a relatively low ionizing radiation, CBCT offers the 3-D representation of hard tissues with limited information on soft-tissue detail.

CBCT exhibits clear advantages over conventional radiographic methods, including controlled magnification, lack of superimposition, absence of geometric distortion, and convenient multiplanar and 3-D displays. These advances offer improved structure visualization and diagnostic efficacy. Continuous software and hardware improvements allow ease and speed in data acquisition, reconstruction, and display. Several commercially available cone beam scanners and third-party software providers provide the dental practitioner a variety of options that can be tailored to their specific needs and applications. Indeed, CBCT finds applications in almost every aspect of dentistry from restorative to periodontal to endodontic to orofacial pain to orthodontic and surgical patients.

An important distinction between CBCT and conventional imaging is the extent of the imaged volume. Normal and pathologic radiographic findings in the teeth and jaws seen on periapical, bitewing, or panoramic radiographs are familiar to all dentists. However, with CBCT, the imaged volume often includes the brain, base of skull, naso- and oropharynx, neck, and cervical spine. Many dentists are unaccustomed to the radiographic normal and pathologic appearance of such structures and may be overwhelmed by the various reconstruction possibilities offered by CBCT technology for imaging these areas. The responsibility of the dentist regarding interpretation of structures outside the orofacial complex and the rights of the patient for correct diagnosis of anomalies affecting these structures have not been clearly delineated.

Although becoming more prevalent and available to dental professionals,

CBCT is far from replacing traditional imaging technologies. Factors limiting its usage include cost for the equipment and imaging studies, higher radiation dose compared to conventional radiographs, relative sophistication of operation, prolonged time required for image manipulation and interpretation, and compromise of image quality around metallic or other dense material. Furthermore, despite enhanced visualization of the orofacial structures, published evidence supporting CBCT's contribution to improved treatment planning and management, as well as treatment outcomes is not always available. Comprehensive selection criteria for utilization of CBCT technology for several dental applications have not been established.

The articles in this volume of the *Journal of the California Dental Association* describe the most common applications of CBCT in dentistry and critically review published studies on CBCT contribution to dental treatment planning and outcomes when available. In the absence of such studies, and recognizing that an expert's opinion is the minimal level of scientific evidence, the authors provide their personal recommendations. Finally, ethical and legal ramifications regarding dentist and patient responsibilities and rights regarding pathologic findings outside the area of interest will be discussed.

Although CBCT technology was originally introduced as state-of-the-art imaging, it is entering the mainstream of everyday dentistry, enriching the diagnostic armamentarium of dental practitioners. It is the intent of the editors and the authors that these reviews will not only present an overview of CBCT utilization in dentistry but, will furthermore, provide a reference source for optimally employing this technology in the management of our patients. ■■■■

CDA JOURNAL, VOL 38, Nº1

Cone Beam Computed Tomography in the Diagnosis of Dental Disease

SOTIRIOS TETRADIS, DDS, PHD; PAUL ANSTEY, DDS; AND STEVEN GRAFF-RADFORD, DDS

ABSTRACT Conventional radiographs provide important information for dental disease diagnosis. However, they represent 2-D images of 3-D objects with significant structure superimposition and unpredictable magnification. Cone beam computed tomography, however, allows true 3-D visualization of the dentoalveolar structures, avoiding major limitations of conventional radiographs. Cone beam computed tomography images offer great advantages in disease detection for selected patients. The authors discuss cone beam computed tomography applications in dental disease diagnosis, reviewing the pertinent literature when available.

AUTHORS

Sotirios Tetradis, DDS, PHD, is a professor and chair in the Section of Oral and Maxillofacial Radiology at the University of California, Los Angeles, School of Dentistry.

Paul Anstey, DDS, is a diplomate of the American Board of Endodontics and maintains a private practice in Beverly Hills, Calif., specializing in microendodontics and implant surgery.

Steven Graff-Radford, DDS, is the director of The Program for Headache and Orofacial Pain at the Cedars- Sinai Medical Center and an adjunct professor at the University of California, Los Angeles, School of Dentistry.

Periapical, bitewing, occlusal, and panoramic radiographs are used in everyday dental practice to provide valuable diagnostic information in dental disease diagnosis. However, these radiographic projections offer a 2-D representation of 3-D anatomic structures with resultant structure superimposition and unpredictable distortion. This major limitation obscures anatomic conspicuity and poses difficulties in radiographic interpretation during caries, periodontal, oral surgery, and endodontic applications.

Cone beam computed tomography, CBCT, offers an alternative to conventional intraoral and panoramic imaging that circumvents the superimposition and distortion problems. At a significantly lower cost compared to conventional medical CT and utilizing a radiation exposure comparable with other dental radiographic modalities, CBCT provides a true 3-D imaging of the orofacial structures. Although its utilization in dentistry focuses mostly on implant, orthodontic and TMJ evaluation, CBCT technology has potential advantages in common dental disease diagnosis.[1]

During the last decade, an increasing number of CBCT systems have become available. CBCT units can be classified according to the imaged volume or field of view, FOV, as large FOV (6 inch to 12 inch or 15 to 30.5 cm) or limited FOV systems (1.6 inch to 3.1 inch or 4 to 8 cm). In general, the greater the FOV the more extensive the anatomic area imaged, the higher the radiation exposure to the patient, and the lower the resolution of the resultant images. Alternatively, limited FOV systems image only a small area of the face, deliver less radiation and produce a higher resolution image. With the limited FOV CBCT scanners, isotropic voxel resolu-

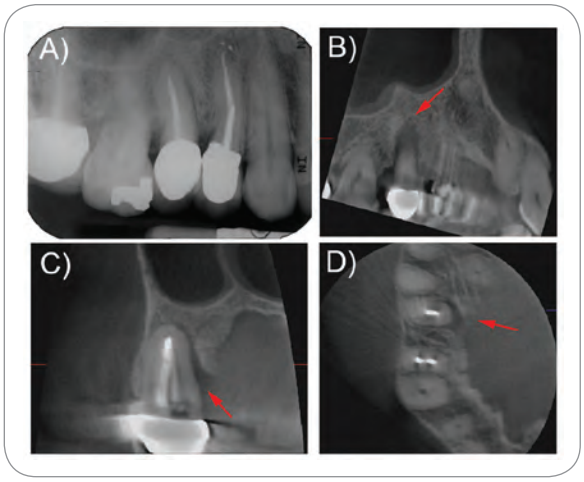

FIGURE 1. Periapical **(A)**, sagittal **(B)**, cross-sectional **(C)**, and axial **(D)** CBCT sections of tooth No. 4. Red arrow on CBCT images points to periodontal defect. CBCT images in this and the remaining figures were generated by the limited FOV 3-D Accuitomo CBCT scanner by J. Morita.

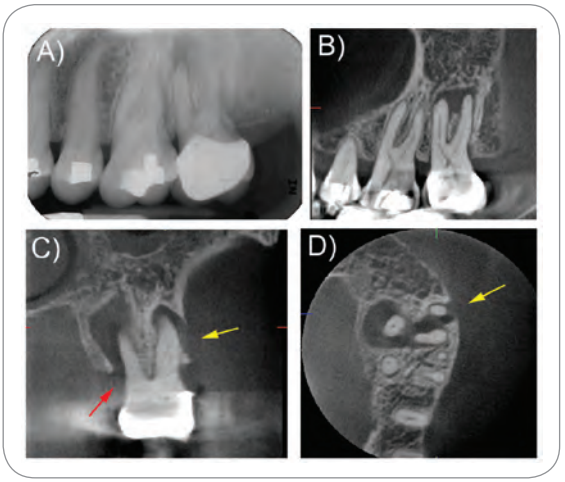

FIGURE 2. Periapical **(A)**, sagittal **(B)**, cross-sectional **(C)**, and axial **(D)** CBCT sections of tooth No. 15. Yellow arrow points to disruption of buccal cortication and red arrow points to periodontal ligament space widening.

tions below 100 µm can be achieved.[2]

Comparative radiation exposure risk from various imaging modalities utilized in dental practice is beyond the scope of the current manuscript. The reader is referred to recent publications comparing effective radiation doses of large, medium, and limited FOV CBCT scanners, medical CT, and conventional intraoral and extraoral radiographs according to the 2007 International Commission on Radiological Protection recommendations.[3,4] An important consideration regarding radiation exposure is that because of the small volume more than one limited FOV scans might be required to examine the whole area of interest, thus increasing the total radiation delivered to the patient.

Applications that do not need highly detailed depiction of structures but require imaging a significant portion of the face, such as for orthodontics or extensive implant reconstruction, could benefit from a moderate to large FOV CBCT scan. Alternatively, applications that require imaging of a small part of the orofacial complex are more appropriately imaged by a limited FOV CBCT system. Typically, dental disease diagnosis falls in the second category. The CBCT parameters should be chosen such that the highest resolution scan can be obtained. This will not only limit patient radiation exposure, but more importantly will provide appropriate diagnostic detail for periodontal and endodontic applications.[5]

In the subsequent sections, the authors review CBCT use for the diagnosis and treatment planning of common dental disease such as caries detection, periodontal evaluation, endodontic applications, tooth impaction, root resorption, and trauma to the teeth.

Caries Detection

Studies comparing the caries detection efficacy of CBCT versus conventional modalities, such as bitewing and periapical intraoral radiographs, are inconclusive. CBCT is reported to more accurately assess proximal caries depth compared to film or storage phosphor periapical radiographs.[6] In a similar study of noncavitated teeth, a large FOV CBCT performed poorer in detection of caries, while a limited CBCT had higher sensitivity only for occlusal caries compared to digital or conventional periapical radiographs.[7] Finally, no difference in the detection of a carious lesion between a limited CBCT and film in proximal premolar surfaces was observed.[8]

Although these and similar reports outline the potential benefit of CBCT technology in caries detection, they are performed in well-controlled experimental settings that do not reflect the reality of everyday dental practice. Beam hardening artifacts are frequent in the imaging of dental structures and particularly tooth crowns.[2] Such artifacts originate from metallic restorations, implants, endodontic restorative material, or other dense objects and create distortion of structures, streaks of bright and dark bands and noisy projection reconstructions that project over adjacent teeth and render diagnosis difficult or unfeasible. In particular, the dark bands may convey the false impression of recurrent caries. Patient movement decreases structure sharpness and definition, and further complicates these artifacts. It has been the authors' experience that at the present time, CBCT technology is not practical or advantageous over intraoral radiography for caries detection. However, if a CBCT scan is taken for other purposes, all teeth present in the imaging volume, should be evaluated for coronal integrity and pathosis.

Periodontal Evaluation

Interdental bone levels can be assessed with conventional radiographs. However, little information can be gained when buccal, lingual, or fractional periodontal bone height needs to be determined because

of superimposition of the alveolar bone with the teeth or roots. Furthermore, partial loss of interdental bone thickness can be difficult to determine on 2-D radiographs. CBCT imaging, by allowing the 3-D evaluation of the periodontal tissues, solves these projection problems of periapical and bitewing radiographs.

Indeed, CBCT performs superiorly in the assessment of artificial buccal or lingual periodontal defects compared to periapical radiographs. However, the two modalities behaved similarly in the detection of interdental bone level.[9] When assessing periodontal bone in dry skulls, CBCT provides better diagnostic and quantitative assessment of periodontal defects compared to periapical radiographs. CBCT is particularly advantageous for the buccal and lingual, as well as furcational assessment of periodontal defects.[10,11] These in vitro findings translate to the clinical setting where CBCT outperformed intraoral radiography in precision and accuracy for the detection of periodontal bone levels following regenerative periodontal therapy.[12] The high agreement of CBCT with surgical measurements prompted the authors to suggest that CBCT may replace surgical re-entry as a technique for assessing regenerative therapy outcomes.

The superior ability of CBCT imaging to evaluate periodontal bone levels can be appreciated in **FIGURE 1**. Although on the periapical radiograph (**FIGURE 1A**) periodontal bone levels around tooth No. 4 appear to be relatively normal, CBCT imaging reveals a deep avertical defect extending from the lingual alveolar crest to the apex of No. 4 (**FIGURES 1-D**).

Periapical Disease

Similar to periodontal disease, the ability of CBCT imaging to bypass anatomic structure superimposition and evaluate the teeth and their supporting structures three-dimensionally is advantageous for detecting periapical disease presence and severity.

CBCT showed improved sensitivity, positive and negative predictive values, and diagnostic accuracy compared to conventional radiographs in experimental periapical lesions in pig and human jaws, and in 888 consecutive patients.[13-15] In a patient study including 74 posterior maxillary and mandibular teeth with a total of 156 roots, CBCT detected 34 percent more periapical lesions compared to periapical radiographs and demonstrated, with higher frequency, periapical lesion expansion into the maxillary sinus, thickening of the sinus mucoperiosteal lining and the presence of untreated root canals.[16] In a similar study of 46 teeth with periapical lesions, the increased CBCT sensitivity for disease detection led to the uniform observer agreement that in 70 percent of the cases, CBCT images provided clinically relevant additional information not detected in periapical radiographs, including improved root and root canal visualization, lesion localization, and relation to vital anatomic structures. The same authors also noted that beam hardening artifacts from endodontic restorative material can distort image quality and create diagnostic difficulties.[16]

FIGURE 2 demonstrates the advantages of CBCT imaging in evaluating the status of periapical tissues. The periapical radiograph (**FIGURE 2A**) clearly demonstrates radiolucency at the apex of No. 15 mesiobuccal and distobuccal roots. However, the palatal root cannot be clearly seen due to slight distortion, and the superimposition of the roots and zygomatic process of the maxilla. Sagittal (**FIGURE 2B**), cross-sectional (**FIGURE 2C**) and axial (**FIGURE 2D**) sections clearly depict the extent of periapical disease around all three roots. Furthermore, these sections demonstrate disruption of the buccal cortex suggesting possible fistula formation (C&D yellow arrows), and widening of the periodontal ligament space at the palatal surface of the palatal root suggesting formation of an endo-perio lesion (red arrow).

FIGURE 3. Sagittal **(A)** and cross-sectional **(B)** images of tooth No. 29 demonstrate the location of canal opening in relation to existing restorative material.

In addition to improved diagnostic accuracy, limited field of view CBCT imaging demonstrates an increased ability to detect and localize anatomic features of the root and root canal system that can affect treatment planning. CBCT more accurately identified root canals compared to digital periapical radiographs. Interestingly, observers utilizing digital periapical radiographs failed to identify one or more root canals in 40 percent of teeth examined. The authors suggested that in these cases, the failure to identify root canals can result in a less optimal healing outcome.[17] Additionally, CBCT produces accurate measurements of root angulation, compared to conventional imaging, and can be used for the evaluation of root curvature.[18,19] **FIGURE 3** demonstrates CBCT images of No. 29 with a partially calcified canal. Although initial access of the canal opening was unsuccessful, CBCT sections provided useful information for angulation and distance of the canal opening that allowed canal identification.

Root Resorption

Although no experimental or clinical studies have evaluated its usefulness in diagnosing external or internal tooth resorption, several case reports demonstrate the advantage of CBCT technology over conventional radiographs not only

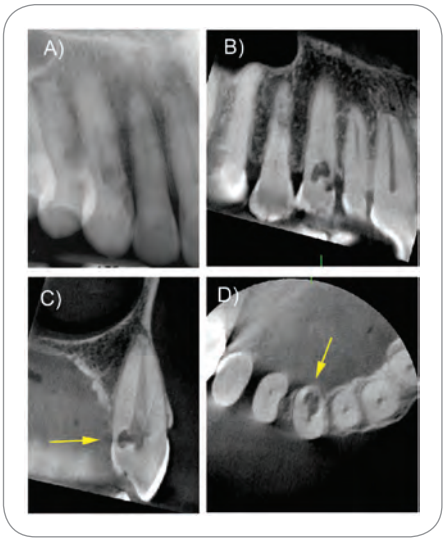

FIGURE 4. Panoramic radiography **(A)**, sagittal **(B)**, cross-sectional **(C)**, and axial **(D)** CBCT sections of tooth No. 27 demonstrate the presence and severity of external (red arrow) and internal root resorption. Yellow arrow points to the extension of internal resorption to the lingual tooth surface.

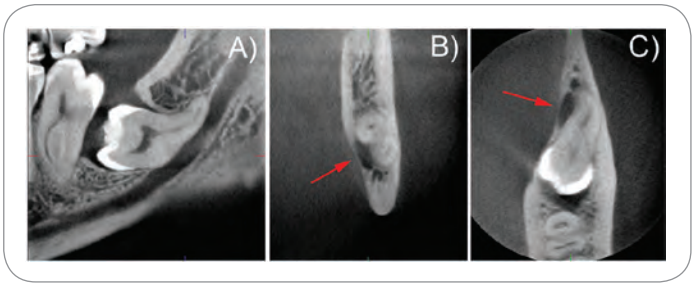

FIGURE 5. Sagittal **(A)**, cross-sectional **(B)**, and axial **(C)** CBCT sections of impacted tooth No. 17. Red arrow points to the lingual position of the inferior alveolar canal.

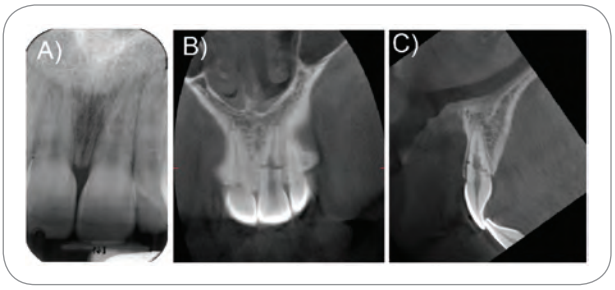

FIGURE 6. Periapical radiograph **(A)**, sagittal **(B)**, and cross-sectional **(C)** CBCT images of tooth No. 9.

in detecting but further in evaluating the extent of resorption.[20-23] There is general agreement that CBCT provides valuable information allowing the exact localization and extent of tooth resorption, as well as possible perforation and communication with the PDL space.[21,24] The authors' experience with many internal and external root resorption cases is in agreement with that assessment. The authors further found CBCT imaging advantageous in the diagnosis, assessment of prognosis, treatment planning, and treatment follow-up of external and internal resorption cases. In the authors' view, limited FOV CBCT is a technological breakthrough in the management of these types of cases.

FIGURE 4 shows a periapical radiograph and CBCT sections of tooth No. 6. On the periapical radiograph internal resorption of No. 6 can be seen. However, the extent and location of the resorption cannot be determined. CBCT sections demonstrate internal root resorption that has eroded a significant part of the tooth toward the lingual aspect of the cervical area. However, the resorption has not perforated the lingual tooth surface (yellow arrow). Lack of perforation supports a favorable outcome in this case after endodontic intervention.

Tooth Impaction

CBCT technology offers clear advantages over conventional radiography for the evaluation of impacted teeth. CBCT demonstrates great usefulness in localizing maxillary canine impaction, evaluating canine angulation and determining resorption of adjacent lateral and central incisors.[25,26] Root development, relation to vital anatomic structures including the inferior alveolar canal, IAC, maxillary sinus and adjacent teeth, the 3-D orientation of the impacted tooth within the alveolus and the detection of any associated pathosis that might cause the impaction can be more accurately determined by CBCT imaging.[27,28] **FIGURE 5** demonstrates CBCT images of impacted No. 17. The close relation of the roots with the inferior alveolar canal, which is positioned lingually to the roots (red arrow), can be appreciated in detail.

Although CBCT scans provide a more precise assessment of tooth impaction, not all impacted teeth require CBCT imaging for diagnosis and treatment planning. It is argued that in the great majority of cases, the relation of the IAC with the roots of impacted mandibular third molars can be evaluated by conventional radiographs. If such films reveal an intimate relationship between the IAC and the roots, CBCT imaging can provide important information for the management of the impacted tooth.[29]

Dental Trauma

One of the more difficult diagnostic tasks in dentistry is dental trauma evaluation. Minimal fracture fragment displacement, structure superimposition, soft-tissue swelling, and the presence of foreign objects can complicate the appearance of tooth fracture in conventional radiographs. Unless the X-ray beam is oriented through the plane of the fracture it may not be possible to separate the fractured root fragments. Furthermore, obtaining good quality intraoral radiographs can be challenging in noncooperative patients.

CBCT imaging is clearly advantageous over conventional radiography for the evaluation of trauma and suspected root

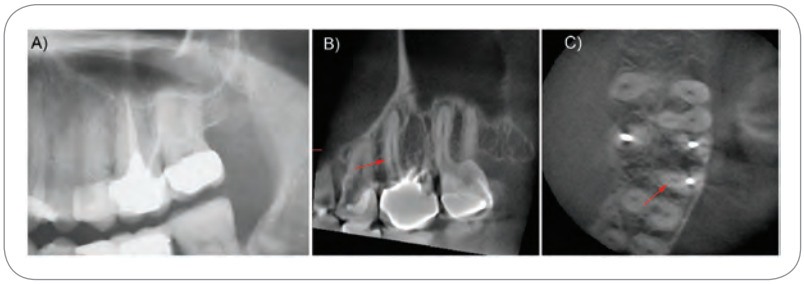

FIGURE 7. Panoramic radiograph **(A)**, sagittal **(B)**, and axial **(C)** CBCT sections of tooth No. 14. Red arrow points to the unfilled canal in the mesio-buccal root of tooth No. 14.

fractures.[30,31] CBCT shows increased sensitivity and greater interobserver variability over conventional periapical radiographs in the detection of experimentally induced horizontal root fractures of central and lateral human incisors. Interestingly, the specificity of both modalities was similar.[32] Additionally, CBCT is statistically significantly more accurate than periapical radiographs in fracture detection of 20 patients with suspected root fractures.[33] **FIGURE 6** illustrates a case where limited FOV CBCT imaging provided central information for the definitive diagnosis of tooth No. 9 root fracture. Periapical radiograph of No. 9 (**FIGURE 6A**) is inconclusive, while sagittal (**FIGURE 6B**) and cross-sectional (**FIGURE 6C**) CBCT images clearly demonstrate the oblique root fracture through the whole root thickness.

Dental Treatment Complications

The authors are not aware of any clinical or experimental studies that have addressed CBCT usefulness in dental treatment complications. However, in the authors' experience, CBCT imaging can prove valuable in cases where a patient's symptoms persist despite appropriate intervention or in cases where a patient develops adverse symptomatology, such as paresthesia, anesthesia, pain, or loss of function. The ability of CBCT to capture the 3-D relation of teeth to anatomic structures such as the inferior alveolar canal, mental foramen/anterior loop, maxillary sinus, restorative materials, dental implants, and other areas of pathosis without any superimposition artifacts, can reveal crucial diagnostic information not available in conventional radiographs.

FIGURE 7 illustrates a case of an endodontically treated tooth No. 14. Although the dentist felt that the endodontic treatment was successful and the panoramic (**FIGURE 7A**) and periapical (not shown) radiographs were unremarkable, the patient complained of persistent pain. CBCT sagittal and axial sections demonstrated the existence of an unfilled second canal in the mesiobuccal root of No. 14 (red arrows).

Importantly, a periapical radiolucency indicative of persistent periapical disease is seen at the apex of the mesiobuccal root. In **FIGURE 8**, radiographs of a patient who developed pain after an endodontic treatment of tooth No. 18 are shown. Periapical radiograph (**FIGURE 8A**) demonstrated endodontic cones significantly extruding past the radiographic apices of both the mesial and distal roots of No. 18. Although the inferior alveolar canal appears to be in close proximity to the apices of No. 18 roots and to the extruded material, the exact relationship of these structures could not be evaluated on conventional radiographs. CBCT images demonstrated that the endodontic cone perforated the roof and extended to the floor of the inferior alveolar canal at the center of the canal (red arrow, **FIGURES 8B-D**). The endodontic cone in the mesial root was located on the buccal of the inferior alveolar canal (yellow arrow, **FIGURE 8D**). Also note persistent periapical radiolucency around the apex of the mesial root of No. 18 seen on periapical and CBCT images.

Conclusions

Over the last decade, CBCT imaging has revolutionized oral and maxillofacial imaging. CBCT technology finds utilization not only in implant and orthodontic applications, but almost in every facet of clinical dentistry. When CBCT scanning is considered, the smallest volume that will image the area of interest should be selected. This will provide higher resolution and lower patient radiation exposure. The ability of CBCT to visualize the 3-D relation of anatomic structures and dental pathology improves diagnosis and treatment planning.

To the best of the authors' knowledge, clear guidelines and evidence-based selection criteria for CBCT utilization have not been established thus far. Based on the published literature and the authors' personal experience, they believe the majority of patients are appropriately managed utilizing conventional radiographs. However, CBCT imaging can be greatly beneficial in diagnosing and treatment planning of select dental patients.

The authors found no indication for CBCT use in caries detection. In cases where periodontal surgery is considered, CBCT provides valuable qualitative and quantitative assessment of periodontal defects. When periodontal or periapical disease cannot be clearly confirmed on periapical radiographs, but is highly suspected based on patient symptomatology, CBCT imaging could be a great diagnostic aid. Additionally, if conventional radiographs suggest anatomic variants such as root curvature or accessory canals, CBCT scans can facilitate accurate assessment and endodontic treatment planning. In most external and internal root resorption cases, CBCT provides valuable information as to whether treatment of these lesions can lead to a favorable outcome.

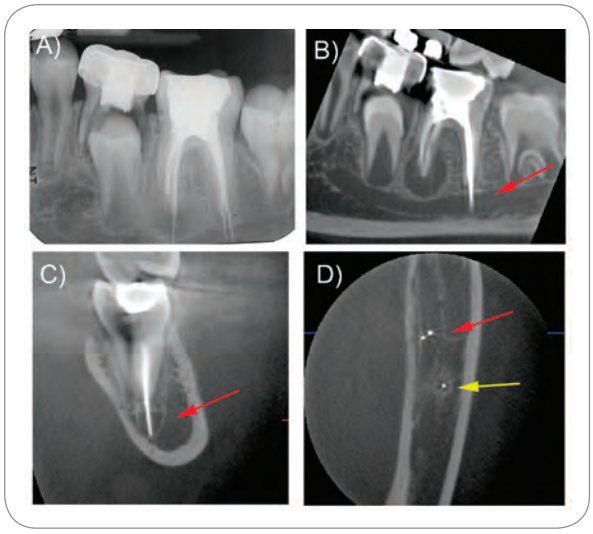

FIGURE 8. Periapical radiograph **(A)**, sagittal **(B)**, cross-sectional **(C)**, and axial **(D)** CBCT sections of tooth No. 18. Red arrow points to the endodontic cone in the distal, while yellow arrow points to the endodontic cone in the mesial root of No. 18.

Impacted teeth in close proximity to vital structures are accurately evaluated by CBCT imaging. Dental trauma can be a very challenging diagnostic task. When conventional radiographs are inconclusive, CBCT can add valuable diagnostic information in suspected root fractures.

Finally, suspected dental treatment complications can be assessed and corrective interventions, if necessary, can be promptly designed. The treating dentist should determine whether the diagnostic benefits gained by CBCT imaging exceed the patient's risk from increased radiation exposure as well as the financial cost. ■■■■

REFERENCES

1. Tyndall DA, Rathore S, Cone beam CT diagnostic applications: caries, periodontal bone assessment, and endodontic applications. *Dent Clin North Am* 52(4):825-41, vii, 2008.
2. Scarfe WC, Farman AG, What is cone-beam CT and how does it work? *Dent Clin North Am* 52(4):707-30, v, 2008.
3. Ludlow JB, Davies-Ludlow LE, White SC, Patient risk related to common dental radiographic examinations: the impact of 2007 International Commission on Radiological Protection recommendations regarding dose calculation. *J Am Dent Assoc* 139(9):1237-43, 2008.
4. Ludlow JB, Ivanovic M, Comparative dosimetry of dental CBCT devices and 64-slice CT for oral and maxillofacial radiology. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 106(1):106-14, 2008.
5. Farman AG, Field of view. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 108(4):477-8, October 2009.
6. Akdeniz BG, Grondahl HG, Magnusson B, Accuracy of proximal caries depth measurements: comparison between limited cone beam computed tomography, storage phosphor and film radiography. *Caries Res* 40(3):202-7, 2006.
7. Haiter-Neto F, Wenzel A, Gotfredsen E, Diagnostic accuracy of cone beam computed tomography scans compared with intraoral image modalities for detection of caries lesions. *Dentomaxillofac Radiol* 37(1):18-22, 2008.
8. Tsuchida R, Araki K, Okano T, Evaluation of a limited cone beam volumetric imaging system: comparison with film radiography in detecting incipient proximal caries. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 104(3):412-6, 2007.
9. Misch KA, Yi ES, Sarment DP, Accuracy of cone beam computed tomography for periodontal defect measurements. *J Periodontol* 77(7):1261-6, 2006.
10. Mol A, Balasundaram A, In vitro cone beam computed tomography imaging of periodontal bone. *Dentomaxillofac Radiol* 37(6):319-24, 2008.
11. Vandenberghe B, Jacobs R, Yang J, Detection of periodontal bone loss using digital intraoral and cone beam computed tomography images: an in vitro assessment of bony and/or infrabony defects. *Dentomaxillofac Radiol* 37(5):252-60, 2008.
12. Grimard BA, Hoidal MJ, et al, Comparison of clinical, periapical radiograph, and cone beam volume tomography measurement techniques for assessing bone level changes following regenerative periodontal therapy. *J Periodontol* 80(1):48-55, 2009.
13. Stavropoulos A, Wenzel A, Accuracy of cone beam dental CT, intraoral digital and conventional film radiography for the detection of periapical lesions. An ex vivo study in pig jaws. *Clin Oral Investig* 11(1):101-6, 2007
14. Patel S, Dawood A, et al, Detection of periapical bone defects in human jaws using cone beam computed tomography and intraoral radiography. *Int Endod J* 42(9):831-8, September 2009.
15. Estrela C, Bueno MR, et al, Accuracy of cone beam computed tomography and panoramic and periapical radiography for detection of apical periodontitis. *J Endod* 34(3):273-9, March 2008.
16. Low KM, Dula K, et al, Comparison of periapical radiography and limited cone-beam tomography in posterior maxillary teeth referred for apical surgery. *J Endod* 34(5):557-62, 2008.
17. Matherne RP, Angelopoulous C, Use of cone beam computed tomography to identify root canal systems in vitro. *J Endod* 34(1):87-9, 2008.
18. Estrela C, Bueno MR, et al, Method for determination of root curvature radius using cone beam computed tomography images. *Braz Dent J* 19(2):114-8, 2008.
19. Peck JL, Sameshima JT, et al, Mesiodistal root angulation using panoramic and cone beam CT. *Angle Orthod* 77(2):206-13, 2007.
20. Patel S, Dawood A, The use of cone beam computed tomography in the management of external cervical resorption lesions. *Int Endod J* 40(9):730-7, 2007.
21. Cotton TP, Geisler TM, et al, Endodontic applications of cone-beam volumetric tomography. *J Endod* 33(9):1121-32, 2007.
22. Maini A, Durning P, Drage N, Resorption: within or without? The benefit of cone beam computed tomography when diagnosing a case of an internal/external resorption defect. *Br Dent J* 204(3):135-7, 2008.
23. Patel S, Kanagasingam S Pitt Ford T, External cervical resorption: a review. *J Endod* 35(5):616-25, 2009.
24. Patel S, New dimensions in endodontic imaging: part 2. Cone beam computed tomography. *Int Endod J* 2009.
25. Liu DG, Zhang WL, et al, Localization of impacted maxillary canines and observation of adjacent incisor resorption with cone beam computed tomography. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 105(1):91-8, 2008.
26. Walker L, Enciso R, Mah J, Three-dimensional localization of maxillary canines with cone beam computed tomography. *Am J Orthod Dentofacial Orthop* 128(4):418-23, 2005.
27. Tamimi D, ElSaid K, Cone beam computed tomography in the assessment of dental impactions. *Semin Orthod* 15(1):57-62, 2009.
28. Mah J, Enciso R, Jorgensen M, Management of impacted cuspids using 3-D volumetric imaging. *J Calif Dent Assoc* 31(11):835-41, November 2003.
29. Flygare L, Ohman A, Preoperative imaging procedures for lower wisdom teeth removal. *Clin Oral Investig* 12(4):291-302, 2008.
30. Cohenca N, Simon JH, et al, Clinical indications for digital imaging in dentoalveolar trauma. Part 2: root resorption. *Dent Traumatol* 23(2):105-13, 2007.
31. Cohenca N, Simon JH, et al, Clinical indications for digital imaging in dentoalveolar trauma. Part 1: traumatic injuries. *Dent Traumatol* 23(2):95-104, 2007.
32. Kamburoglu K, Ilker Cebeci AR, Grondahl HG, Effectiveness of limited cone beam computed tomography in the detection of horizontal root fracture. *Dent Traumatol* 25(3):256-61, 2009.
33. Bernardes RA, de Moraes IG, et al, Use of cone beam volumetric tomography in the diagnosis of root fractures. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 108(2):270-7, 2009.

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Cone Beam Computed Tomography Imaging in the Evaluation of the Temporomandibular Joint

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ABSTRACT A radiological examination is an essential part of the diagnosis and management of temporomandibular joint disease. Accurate evaluation of the TMJ has been difficult due to the superimposition of other structure in conventional radiographs. Cone beam computed tomography provides precise imaging of TMJ anatomy without superimposition and distortion. The CBCT's preciseness enables practitioners to better identify problems, as well for other strategies. Common conditions of the TMJ in which CBCT plays a role are discussed.

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Although the use of computed tomography, CT, as a diagnostic tool has been an indispensable in medicine for many years, its application in dentistry has been more limited. This was mainly due to the rather high cost of the equipment, the large space required for its operation, and the high dose of radiation involved. The use of CT results in significantly higher absorbed doses compared with panoramic radiography and linear tomography. It has therefore been of great concern whether the superiority of CT in terms of imaging outweighs the biological risks for the patient.[1-3] Nevertheless, the number of CT examinations in dentistry has rapidly increased in recent years, particularly for examination of pathological conditions and trauma in the maxillofacial region.[4-7]

Cone beam computed tomography, CBCT, for dental and maxillofacial diagnostic osseous tasks has been rapidly developed as an alternative to conventional CT for assessment of the temporomandibular joint, TMJ, and presurgical implant treatment planning. CBCT results in images of CT-like quality, yet is made with less-expensive equipment and components, shorter patient examination time, and much lower radiation dose than required for conventional CT.[8-12] In addition, the CBCT scanning procedure and the image reconstruction software are user friendly.

Due to the increasing use of the CBCT, the aim of this paper is to assess the utility of CBCT for diagnosis of TMJ disease.

TMJ Imaging

Studies have shown that clinical assessment of TMJ disorders is often inconsistent with joint imaging studies.[13,14] Additionally, TMJ problems involve both hard and soft-tissue and the astute

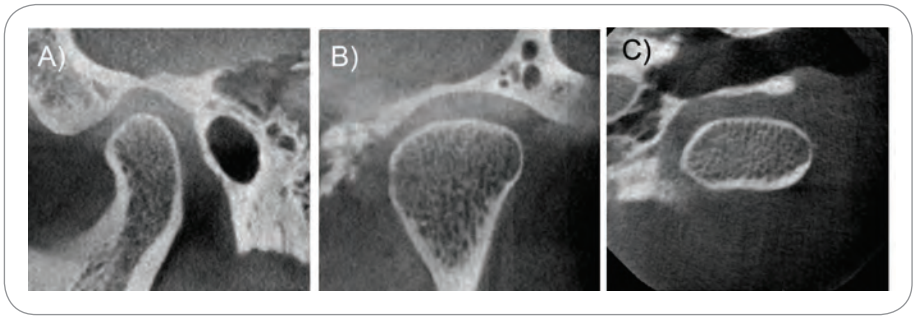

FIGURE 1. Normal TMJ in the closed position seen on corrected lateral **(A)**, coronal **(B)**, and axial **(C)** CBCT sections.

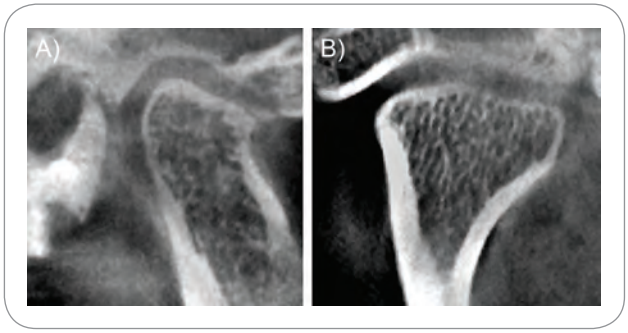

FIGURE 2. Bone remodeling on lateral **(A)** and coronal **(B)** CBCT sections showing flattening and cortical thickening of the antero-superior surface of the condylar head and glenoid fossa.

clinician needs to base the decision to order imaging on the type of tissue to be imaged. The TMJ imaging protocol begins with hard-tissue imaging to evaluate the bony contours, the positional relationship of the condyle and fossa, and the range of motion. In many cases, a radiographic examination is a decisive factor for the differential and final diagnoses of several pathological conditions of the TMJ.[15-17]

Prior to CT and CBCT, no single imaging technique was readily available for accurate, easily interpreted representations of all osseous aspects of the TMJ complex and associated structures. While panoramic radiography has frequently been used as a simple, low-cost method to evaluate the bony structures of the TMJ, it suffers serious limitations. In this technique, the lateral slope and central portions of the condyle are visualized because of the oblique orientation of the beam with respect to the condyle long axis. However, findings are usually limited to fractures, obvious erosions, sclerosis, and osteophytes of the condyle.[18] Further, the depiction of the articular eminence and fossa is not adequate for diagnosis of other than advanced changes of shape and structure because of superimposition by the base of the skull and zygomatic arch.

For a more detailed evaluation of the TMJ, conventional plane projections such as the panoramic, modified TMJ-specific panoramic, transcranial, and, to a lesser extent, Townes and submentovertex, SMV, can be used to provide an appreciation of TMJ anatomy. Conventional tomography avoids anatomy superimposition and unpredictable magnification, and has been used as a method of choice for bony TMJ examination.[19-23] However, when compared with microscopy, tomography underestimates small bone abnormalities and thus the diagnostic accuracy is limited.[24]

CT proved valuable for the evaluation of bony TMJ details in early 1980s and is superior to hypocycloidal tomography, although not by all investigators.[19,20,25] In patients with expansive masses, ankylosis, arthritides, osteoarthritis or fractures, CT is superior to both conventional tomography and magnetic resonance imaging, MRI, for the assessment of bony TMJ components.[26,27] MRI has the added advantage over CT scans to depict soft tissues such as the disc, ligaments, and muscles, and may be more useful than CTs when the patient presents with internal derangement or joint dysfunction.[28,29] Tasaki and Westesson found a 95 percent accuracy of diagnosis in sagittal and a 93 percent accuracy in coronal MRI of fresh autopsy specimens.[30] The use of an MRI has been the preferred imaging modality for the overall assessment of the TMJ.[31]

The introduction of the CBCT technology specifically designed for use in dentistry has opened up new opportunities in TMJ imaging. CBCT has been recognized as a reliable method for the examination of the osseous components of the TMJ. This technique is easy to perform, is reproducible, and delivers a relatively low dose to the patient.[32-34]

CBCT provides images that can be reconstructed in planes parallel or perpendicular to the long axis of the condyle instead of the true anatomic coronal and sagittal planes. This results in high quality images of the bony components in all planes. Because the patients are positioned in a relatively natural head position, the TMJ positional relationships can be more accurately evaluated than in a CT examination where the patient is supine. The images generated via CBCT are not distorted and provide good bone density evaluation (**FIGURE 1**).

Application of CBCT in the Management of TMJ Disorders

Patients with TMJ disorders constitute a heterogeneous group. Many have symptoms that are not directly related to the joints proper. Although the clinical assessment of the TMJ provides limited information with respect to its status, imaging should only be performed if a thorough physical examination indicates the need for more information.

The goals of TMJ imaging are to evaluate the integrity of the structures when disorders are suspected, to confirm

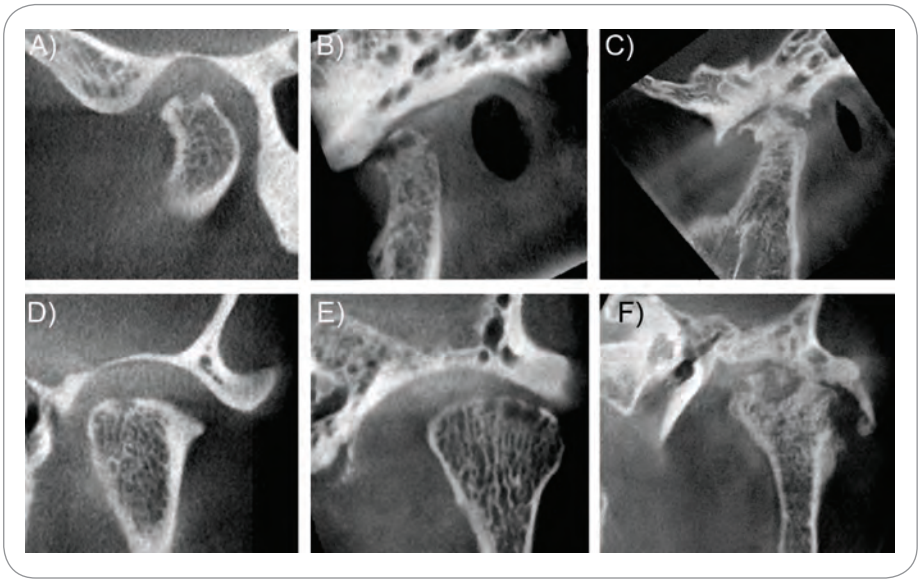

FIGURE 3. Progressive osteoarthritic changes depicted on lateral **(A, B, C)** and coronal **(D, E, F)** CBCT sections. Mild erosion of the condylar head and normal glenoid fossa **(A, D)**, moderate erosion, bone sclerosis, and reduced joint space with lateral position of the condylar head within the glenoid fossa on the coronal section **(B, E)**, and severe erosion, bone sclerosis, osteophyte formation, periosteal bone reaction, and significantly reduced joint space **(C, F)**.

the extent and stage the progression of disorders, and to evaluate the effects of treatment. Below are common conditions of the TMJ in which imaging plays a diagnostic or confirmatory role.

Remodeling

Remodeling is a physiologic process that aims to adapt the structure of TMJ to the mechanical forces applied to the joint. Excessive forces may cause alteration of the shape of the condyle and articular eminence.[35,36] This adaptive response may result in a flattening of curved joint surfaces, increased bone density (sclerosis), and absence of destruction or degeneration of articular soft-tissue. TMJ remodeling occurs throughout one's adult life and is considered abnormal only if accompanied by clinical signs and symptoms of pain or dysfunction, or if the degree of remodeling seen radiographically is judged to be severe. CBCT findings may include flattening, the cortical thickening of articulating surfaces, and subchondral sclerosis (**FIGURE 2**). These changes may affect the condyle, temporomandibular components, or both.

Osteoarthritis

Degenerative arthritis or osteoarthritis is an age-related disorder, and the most common pathological condition of the TMJ. Osteoarthritic bony changes include irregular cortical outlines, erosions, osteophyte formation, subchondral cyst formation, resorption of the condylar head, and reduced joint space[37-45] (**FIGURE 3**). These changes are most commonly seen on the condyle but may also involve the mandibular fossa or articular eminence. A joint with osteoarthritic changes may also demonstrate flattening or sclerosis.

CBCT is a valuable imaging technique for the diagnosis of degenerative changes of the TMJ.[33,34] Honda et al. evaluated the comparative diagnostic reliability of CBCT and helical CT (HCT) in detecting osseous abnormalities (erosions and osteophytes) of the TMJ condyle.[34] They determined that the spatial resolution of CBCT is superior to that of HCT. They emphasized that because of its high image quality, decreased cost, and radiation dose, CBCT is a viable diagnostic alternative to HCT for detecting erosions and osteophytes in the TMJ. CBCT images provide superior reliability and greater accuracy than corrected-angle linear tomography and TMJ panoramic projections in the detection of condylar cortical erosion.[46]

Inflammatory Arthritis

A general classification of arthritis divides the diseases into inflammatory, degenerative, infectious, metabolic, and traumatic categories. The inflammatory arthritides are a heterogeneous group of systemic disorders that manifests as synovial membrane inflammation in several joints.[47,48] The group includes rheumatoid arthritis, juvenile idiopathic arthritis, psoriatic arthritis, ankylosing spondylitis, and Reiter syndrome. When an inflammatory disorder of the TMJ is suspected, CBCT is recommended for evaluation of subtle abnormalities. Both joints should be imaged for comparison. Cortical erosions most often involve the articular eminence and the anterior aspect of the condylar head. CBCT images also show subchondral sclerosis, flattening of articulating surfaces, subchondral cysts, and osteophyte formation. The radiographic appearance of inflammatory arthritis is not specific but can be very similar to osteoarthritis. However, the degree of joint destruction is more advanced. When CBCT findings demonstrate severe arthritic changes of the TMJ that cannot be supported by clinical findings or patient's age, the possibility of inflammatory arthritis should be entertained. Correlation with patient symptomatology with other joints, as well as blood tests, might be necessary to further evaluate the patient. Clinical findings include palpable pain in the TMJ, crepitation, and bite changes with developing contralateral and anterior open bite and limited opening.

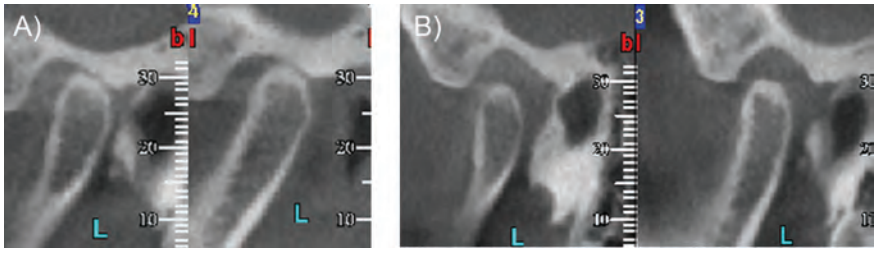

FIGURE 4. Retruded position of the condylar head in closed-mouth position **(A)** and limited translatory movement of the condyle upon opening **(B)** suggest disk displacement.

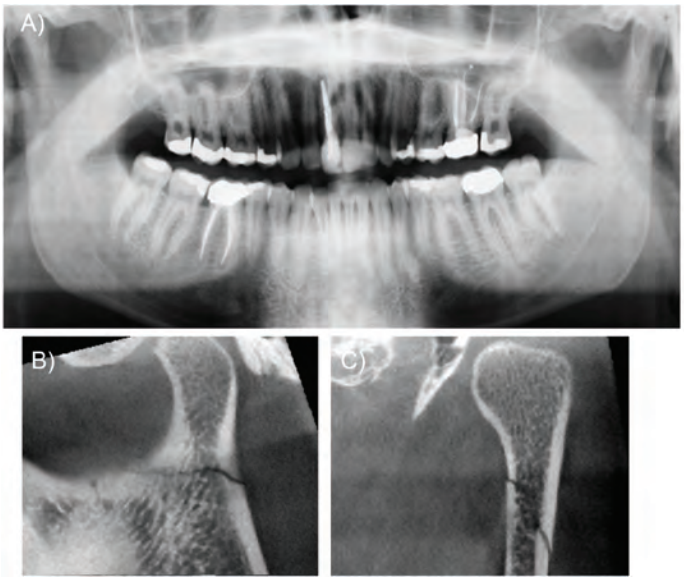

FIGURE 5. Condylar neck fracture cannot be seen on the panoramic radiograph **(A)**. However, lateral **(B)** and coronal **(C)** CBCT sections demonstrate a complete, oblique, minimally displaced fracture of the left condylar neck.

Internal Derangement

Internal derangement of the TMJ is defined as an abnormal positional relationship of the disc relative to the mandibular condyle and articular eminence. Clinically, the derangement may be indicated by clicking in the affected joint or by a restricted opening. Clicking in the TMJ associated with the internal derangement is usually due to the disc displacement being reduced during the opening movement, but a derangement that does not reduce and is associated with restricted opening is characterized as close-locked. The disc cannot be visualized with CBCT. However, disc displacement can reposition the condyle from its central position within the glenoid fossa to a posterior position in the fossa, suggesting an internal derangement. Furthermore, in the case of disc displacement without reduction, the condyle may be restricted in the opening movement.[49,50]

The concentric, posterior, or lateral localization of the condyle within the joint space in closed position should be evaluated on the CBCT images. Furthermore, the translatory movement of the condyle upon opening in relation to the articular eminence should be assessed (**FIGURE 4**). Deviations from the norm can raise suspicions for internal derangement. If clinically indicated, MRI is the method of choice to provide definitive diagnostic information for the TMJ soft-tissue components.

Fracture

Fractures of the TMJ usually occur at the condylar neck and often are accompanied by condylar head dislocation. They can be classified according to location (intracapsular, extracapsular, or subcondylar), type (nondisplaced, displaced, or dislocated), or direction of the fracture (vertical, horizontal, or sagittal).[51,52]

CBCT is useful in the evaluation of TMJ trauma and offers superior anatomic visualization compared to plain radiographs without superimposition of anatomic structures.[52,53] Also, cortical outline irregularity and condylar medial displacement can be assessed on CBCT (**FIGURE 5**). An MRI should be considered in cases of capsular tear and hemarthrosis, where detailed soft-tissue evaluation is needed.

In cases of facial trauma and limited opening, fractures of the zygomatic arch also should be considered. In such cases, the coronoid process may impinge on the fractured zygoma, limiting jaw opening. The limitation and imaging for this would be similar to what is discussed below for coronoid hyperplasia.

Ankylosis

Ankylosis is a fibrous or bony union between joint components and can be caused by trauma, rheumatoid arthritis, or infection. Conventional images may reveal little useful information other than a limited amount of condylar translation.[54] A CBCT examination is recommended, if ankylosis is clinically suspected, as it provides superior visualization of the osseous components. In fibrous ankylosis, the articulating surfaces are usually irregular because of erosions and joint space is narrow. In bony ankylosis, no joint space, at least in parts of the joint, is visible. Secondary degenerative changes are common (**FIGURE 6**). Patients have no or severely limited condylar translation movement in opened-mouth views.

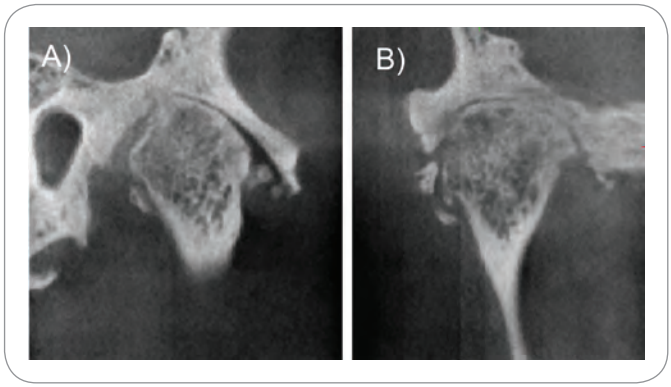

FIGURE 6. Osseous ankylosis on lateral **(A)** and coronal **(B)** CBCT sections showing irregular articular surface, narrow joint space, and continuity of the condylar head with the glenoid fossa at the middle aspect of the condyle. Additionally, small bony fragments, probably representing detached osteophytes, are seen within the joint space.

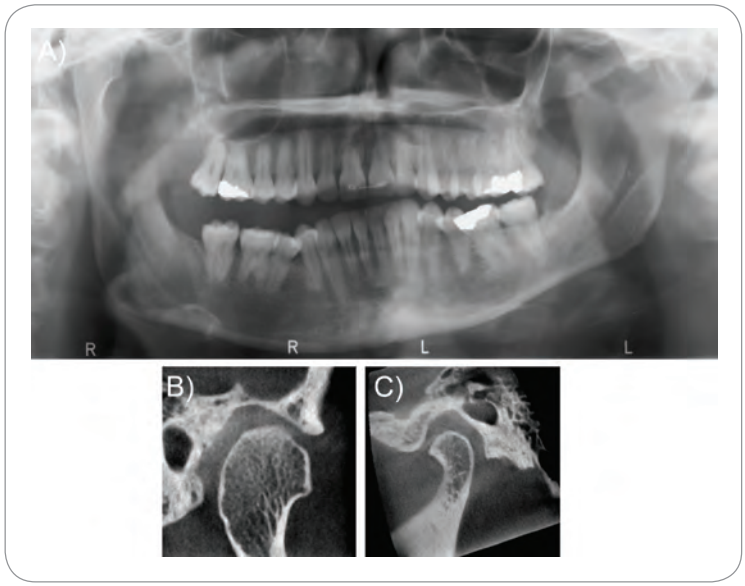

FIGURE 7. Right condylar hyperplasia seen on panoramic **(A)** and lateral **(B)** CBCT sections. Lateral section of the normal left condyle **(C)** is shown for comparison.

Developmental Abnormalities of the TMJ

When clinical examination reveals a facial asymmetry, especially progressive asymmetry, a developmental disorder such as condylar aplasia, hypoplasia, or hyperplasia (**FIGURE 7**) should be suspected. A CBCT offers optimal evaluation of the extent of deformity.[55] Radiographic features include hyperplastic or hypoplastic condyle (unilateral or bilateral), joint remodeling (flattened, deformed), and bifid or split condyle. Because disk derangement may cause a facial asymmetry in young patients, a MRI may be appropriate in some cases.[54]

Coronoid Hyperplasia

Coronoid process hyperplasia may be developmental or acquired, resulting in elongation of the coronoid process. Usually the patient is asymptomatic until the hyperplastic coronoid process impinges on the medial surface of the zygomatic arch or the posterior surface of the maxilla during opening, restricting condylar translation. The elongated coronoid process and its relation to the zygomatic arch and posterior aspect of the maxilla can be clearly visualized on CBCT scans. It is important that CBCT scans are taken in the closed and open position, such that the exact contact point of the coronoid process with the zygomatic arch or maxilla are revealed.

Synovial Chondromatosis

Synovial chondromatosis is a benign tumor-like disorder of the joint characterized by chondrometaplasia of the synovial membrane, in which cartilaginous nodules form and may become pedunculated and/or detach from the synovial membrane, becoming loose bodies within the joint space.[56-58] Clinical symptoms often are characterized by joint swelling, pain, and joint dysfunction. CBCT findings of synovial chondromatosis include the presence of multiple, calcified, loose bodies in the joint space, widening of the joint space, irregular, or sclerotic glenoid fossa. These calcifications follow the condyle movement in an open position. The condyle may appear normal or may exhibit osseous changes similar to those in osteoarthritis (**FIGURE 8**).

Benign Tumors

Benign lesions affecting the TMJ include osteomas, osteochondromas, Langerhans histiocytosis, and osteoblastomas. Osteochondroma, the most common benign TMJ tumor is most commonly seen in the second or third decade of life. It is a slow-growing, exophytic lesion that arises from the cortex of bone and is capped with cartilage. Condylar osteochondroma can result in facial asymmetry, malocclusion, cross-bite on the contralateral side and lateral open bite on the affected side, open deviation, hypomobility, pain, and clicking. Osteochondroma of the mandibular condyle may arise on different sites around the condyle and present diverse shapes on panoramic radiographs.[59] CBCT imaging shows enlarged condyle with irregular outline and altered trabecular pattern, or an abnormal, pedunculated mass attached to the condyle. The tumor may erode adjacent osseous structures (**FIGURE 9**).

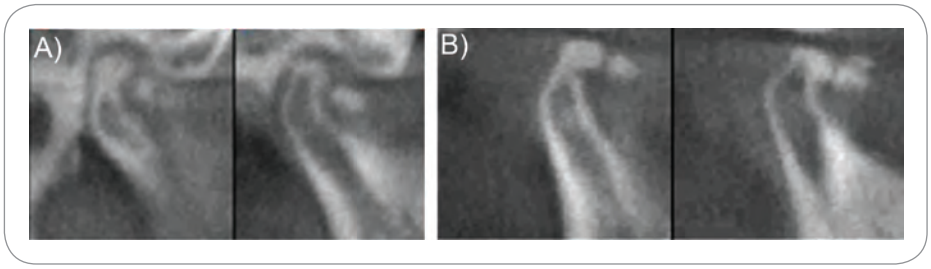

FIGURE 8. Synovial chondromatosis on lateral CBCT sections in closed **(A)** and open **(B)** position showing calcifications within the joint space that follow the condylar movement.

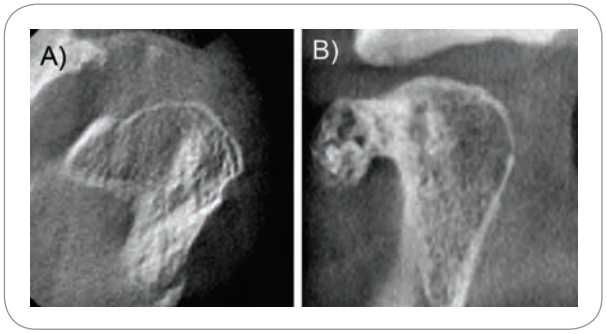

FIGURE 9. Osteochondroma on axial **(A)** and lateral **(B)** CBCT sections showing an exophytic lesion located on the anterior surface of the condylar head. These images show the continuity of the normal condylar trabeculation with the tumor.

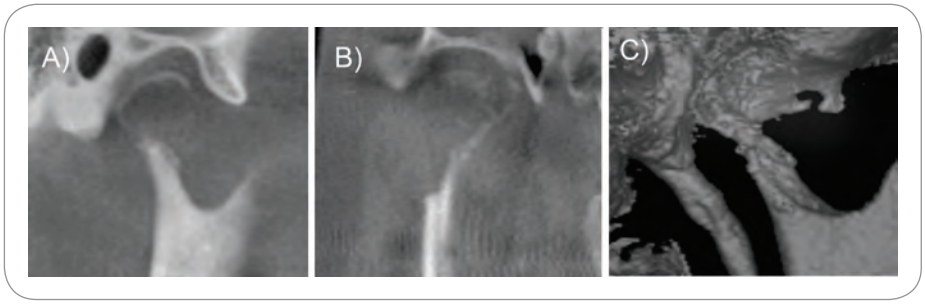

FIGURE 10. Metastatic breast carcinoma on lateral **(A)** and coronal **(B)** sections, and 3-D reconstructions **(C)** showing ill-defined, radiolucent, destructive lesion of the condylar head.

Malignancies

Malignancy of the TMJ is rare. The most common malignant lesion that affect the TMJ is metastasis from a distant site.[60-62] However, primary condylar malignancy, such as osteosarcoma or chondrosarcoma, or extension of local disease have also been reported.[62,63] Malignancies of the TMJ are notable for their atypical and misleading clinical presentation that usually mimics more common disorders, such as osteoarthritis. Patients often have symptoms of TMJ dysfunction such as pain, limited mandibular opening, mandibular deviation, unilateral facial swelling, and external auditory canal obstruction. When these patients do not respond to appropriate therapy, the clinician should recognize that the initial diagnosis might be incorrect.

CBCT can offer great advantages in the diagnosis of TMJ malignancy. Typically, malignant tumors show variable degrees of bone destruction with minimal expansion and erosive, ill-defined, irregular margins (**FIGURE 10**). If a malignancy is suspected on a CBCT, advanced imaging such as an MRI or CT with contrast is recommended for evaluation of local expansion of the lesion in the soft tissues, as well as for evaluation of the regional lymph nodes. In case of metastatic disease, a complete work-up with nuclear scan, whole body CT, and PET scanning might be appropriate.

Conclusions

CBCT has significantly increased the diagnostic abilities of the clinician at a lowered cost to the patient and lower radiation dosage compared with CT. CBCT images provide greater detail of the extent of damage to the articular surfaces from trauma, inflammatory disease, or degenerative processes. CBCT has become the imaging of choice for presurgical evaluation in surgery, for dental implants, and is replacing older imaging modalities for evaluation of TMJ disease. Although CBCT does not image soft-tissue, such as disc position relative to the condyle and fossa, appropriate clinical evaluation can usually determine if a disc displacement is a factor that needs to be treated. Most TMJ disc dislocations self-reduce and are painless. Those derangements that are painful or do not reduce are in a minority and require further imaging as part of the assessment. ■■■■

REFERENCES

1. Christiansen EL, Thompson JR, et al, CT number characteristics of malpositioned TMJ menisci. Diagnosis with CT number highlighting (blinkmode). *Invest Radiol* 22(4):315-21, 1987.
2. Clark DE, Danforth RA, et al, Radiation absorbed from dental implant radiography: a comparison of linear tomography, CT scan, and panoramic and intraoral techniques. *J Oral Implantol* 16(3):156-64, 1990.
3. Dula K, Mini R, et al, The radiographic assessment of implant patients: decision-making criteria. *Int J Oral Maxillofac Implants* 16(1):80-9, 2001.
4. Parks ET, Computed tomography applications for dentistry. *Dent Clin North Am* 44(2):371-94, 2000.
5. Cavalcanti MG, Ruprecht A, et al, 3-D volume rendering using multislice CT for dental implants. *Dentomaxillofac Radiol* 31(4):218-23, 2002.
6. De Bont LG, van der Kuijl B, et al, Computed tomography in differential diagnosis of temporomandibular joint disorders. *Int J Oral Maxillofac Surg* 22(4):200-9, 1993.
7. Bamgbose BO, Adeyemo WL, et al, Cone beam computed tomography (CBCT): the new vista in oral and maxillofacial imaging. *Nig Q J Hosp Med* 18(1):32-5, 2008.
8. Preda L, Di Maggio EM, et al, Use of spiral computed tomography for multiplanar dental reconstruction. *Dentomaxillofac Radiol* 26(6):327-31, 1997.
9. Cohnen M, Kemper J, et al, Radiation dose in dental radiology. *Eur Radiol* 12(3):634-7, 2002.
10. Danforth RA, Cone beam volume tomography: a new digital imaging option for dentistry. *J Calif Dent Assoc* 31(11):814-5, 2003.

11. Hashimoto K, Arai Y, et al, A comparison of a new limited cone beam computed tomography machine for dental use with a multidetector row helical CT machine. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 95(3):371-7, 2003.
12. Schulze D, Heiland M, et al, Radiation exposure during midfacial imaging using 4- and 16-slice computed tomography, cone beam computed tomography systems and conventional radiography. *Dentomaxillofac Radiol* 33(2):83-6, 2004.
13. Paesani D WP, Hatala MP, Accuracy of clinical diagnosis for TMJ internal derangement and arthrosis. *Oral Surg Oral Med Oral Pathol* 73(3):360-3, March 1992.
14. Roberts C KR, Tallents RH, et al, The clinical predictability of internal derangements of the temporomandibular joint. *Oral Surg Oral Med Oral Pathol* 71(4):412-4, April 1991.
15. Roberts D, Pettigrew J, et al, 3-D imaging and display of the temporomandibular joint. *Oral Surg Oral Med Oral Pathol* 58(4):461-74, 1984.
16. Benson BW, Otis LL, Disorders of the temporomandibular joint. *Dent Clin North Am* 38(1):167-85, 1994.
17. Nilner M, Petersson A, Clinical and radiological findings related to treatment outcome in patients with temporomandibular disorders. *Denomaxillofac Radiol* 24:128-31, 1995.
18. Epstein JB, Caldwell J, et al, The utility of panoramic imaging of the temporomandibular joint in patients with temporomandibular disorders. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 92(2):236-9, 2001.
19. Larheim TA, Kolbenstvedt A, Osseous temporomandibular joint abnormalities in rheumatic disease. Computed tomography versus hypocycloidal tomography. *Acta Radiol* 31(4):383-7, 1990.
20. Larheim TA, Kolbenstvedt A, High-resolution computed tomography of the osseous temporomandibular joint. Some normal and abnormal appearances. *Acta Radiol Diagn* (Stockh) 25(6):465-9, 1984.
21. Tanimoto K, Petersson A, et al, Comparison of computed with conventional tomography in the evaluation of temporomandibular joint disease: a study of autopsy specimens. *Dentomaxillofac Radiol* 19(1):21-7, 1990.
22. Cholitgul W, Petersson A, et al, Diagnostic outcome and observer performance in sagittal tomography of the temporomandibular joint. *Dentomaxillofac Radiol* 19(1):1-6, 1990.
23. Akerman S, Kopp S, et al, Macroscopic and microscopic appearance of radiologic findings in temporomandibular joints from elderly individuals. An autopsy study. *Int J Oral Maxillofac Surg* 17(1):58-63, 1988.
24. Flygare L, Rohlin M, et al, Microscopy and tomography of erosive changes in the temporomandibular joint. An autopsy study. *Acta Odontol Scand* 53(5):297-303, 1995.
25. Sukovic P, Cone beam computed tomography in craniofacial imaging. *Orthod Craniofac Res 6* (suppl)1:31-6, discussion 179-82, 2003.
26. Westesson PL, Katzberg RW, et al, CT and MR of the temporomandibular joint: comparison with autopsy specimens. *AJR Am J Roentgenol* 148(6):1165-71, 1987.
27. Larheim TA, Current trends in temporomandibular joint imaging. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 80(5):555-76, 1995.
28. Greess H, Anders K, Indications for validity of computed tomography and magnetic resonance imaging of the temporomandibular joint. *Rontgenpraxis* 56(1):1-11, 2005.
29. Takaku S, Sano T, et al, A comparison between magnetic resonance imaging and pathologic findings in patients with disc displacement. *J Oral Maxillofac Surg* 56(2):171-6, discussion 7, 1998.
30. Tasaki MM Westesson PL, Temporomandibular joint: diagnostic accuracy with sagittal and coronal MR imaging. *Radiology* 186(3):723-9, 1993.
31. Larheim TA, Westesson PL, An evidence-based approach to diagnosis and treatment. TMJ imaging in TMDs. Chicago, Quintessence Books, pages 149-79, 2006.
32. Arai Y, Tammisalo E, et al, Development of a compact computed tomographic apparatus for dental use. *Dentomaxillofac Radiol* 28(4):245-8, 1999.
33. Honda K, Larheim TA, et al, Ortho cubic super-high resolution computed tomography: a new radiographic technique with application to the temporomandibular joint. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 91(2):239-43, 2001.
34. Honda K, Larheim TA, et al, Osseous abnormalities of the mandibular condyle: diagnostic reliability of cone beam computed tomography compared with helical computed tomography based on an autopsy material. *Dentomaxillofac Radiol* 35(3):152-7, 2006.
35. Smartt JM, Jr., Low DW, et al, The pediatric mandible: I. A primer on growth and development. *Plast Reconstr Surg* 116(1):14e-23e, 2005.
36. Arnett GW, Milam SB, et al, Progressive mandibular retrusion-idiopathic condylar resorption. Part II. *Am J Orthod Dentofacial Orthop* 110(2):117-27, 1996.
37. Martinez Blanco M, Bagan JV, et al, Osteoarthrosis of the temporomandibular joint. A clinical and radiological study of 16 patients. *Med Oral* 9(2):110-5, 6-10, 2004.
38. Alexiou K, Stamatakis H, et al, Evaluation of the severity of temporomandibular joint osteoarthritic changes related to age using cone beam computed tomography. *Dentomaxillofac Radiol* 38(3):141-7, 2009.
39. Yamada K, Tsuruta A, et al, Morphology of the articular eminence in temporomandibular joints and condylar bone change. *J Oral Rehabil* 31(5):438-44, 2004.
40. Miles D, Van Dis M, et al, Disorders of the temporomandibular joint. Oral and maxillofacial radiology: radiologic/pathologic correlations. Philadelphia, Penn., WB Saunders pages 275-81, 1991.
41. Gynther GW, Tronje G, Comparison of arthroscopy and radiography in patients with temporomandibular joint symptoms and generalized arthritis. *Dentomaxillofac Radiol* 27(2):107-12, 1998.
42. Holmlund A, Hellsing G, Arthroscopy of the temporomandibular joint. A comparative study of arthroscopic and tomographic findings. *Int J Oral Maxillofac Surg* 17(2):128-33, 1988.
43. Bertram S, Rudisch A, et al, Diagnosing TMJ internal derangement and osteoarthritis with magnetic resonance imaging. *J Am Dent Assoc* 132(6):753-61, 2001.
44. Emshoff R, Brandlmaier I, et al, Condylar erosion and disc displacement: detection with high-resolution ultrasonography. *J Oral Maxillofac Surg* 61(8):877-81, 2003.
45. Gynther GW, Tronje G, et al, Radiographic changes in the temporomandibular joint in patients with generalized osteoarthritis and rheumatoid arthritis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 81(5):613-8, 1996.
46. Honey OB, Scarfe WC, et al, Accuracy of cone beam computed tomography imaging of the temporomandibular joint: comparisons with panoramic radiology and linear tomography. *Am J Orthod Dentofacial Orthop* 132(4):429-38, 2007.
47. Ozcan I, Ozcan KM, et al, Temporomandibular joint involvement in rheumatoid arthritis: correlation of clinical, laboratory and magnetic resonance imaging findings. *B-Ent* 4(1):19-24, 2008.
48. Helenius LM, Tervahartiala P, et al, Clinical, radiographic and MRI findings of the temporomandibular joint in patients with different rheumatic diseases. *Int J Oral Maxillofac Surg* 35(11):983-9, 2006.
49. Pullinger AG, White SC, Efficacy of TMJ radiographs in terms of expected versus actual findings. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 79(3):367-74, 1995.
50. White SC, Pullinger AG, Impact of TMJ radiographs on clinician decision making. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 79(3):375-81, 1995.
51. Schuknecht B, Graetz K, Radiologic assessment of maxillofacial, mandibular, and skull base trauma. *Eur Radiol* 15(3):560-8, 2005.
52. Shintaku WH, Venturin JS, et al, Applications of cone beam computed tomography in fractures of the maxillofacial complex. *Dent Traumatol* 25(4)358-66, 2009.
53. Terakado M, Hashimoto K, et al, Diagnostic imaging with newly developed ortho cubic super-high resolution computed tomography (Ortho-CT). *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 89(4):509-18, 2000.
54. Brooks SL, Brand JW, et al, Imaging of the temporomandibular joint: a position paper of the American Academy of Oral and Maxillofacial Radiology. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 83(5):609-18, 1997.
55. Boeddinghaus R, Whyte A, Current concepts in maxillofacial imaging. *Eur J Radiol* 66(3):396-418, 2008.
56. Peng LW, Yan DM, et al, Synovial chondromatosis of the temporomandibular joint: a case report with bilateral occurrence. *J Oral Maxillofac Surg* 67(4):893-5, 2009.
57. Yokota N, Inenaga C, et al, Synovial chondromatosis of the temporomandibular joint with intracranial extension. *Neurol Med Chir* (Tokyo) 48(6):266-70, 2008.
58. Mandrioli S, Polito J, et al, Synovial chondromatosis of the temporomandibular joint. *J Craniofac Surg* 18(6):1486-8, 2007.
59. Zhang J, Wang H, et al, Osteochondromas of the mandibular condyle: variance in radiographic appearance on panoramic radiographs. *Dentomaxillofac Radiol* 37(3):154-60, 2008.
60. Miles BA, Schwartz-Dabney C, et al, Bilateral metastatic breast adenocarcinoma within the temporomandibular joint: a case report. *J Oral Maxillofac Surg* 64(4):712-8, 2006.
61. Kaufmann MG, Perren A, et al, Condylar metastasis. Review of the literature and report of a case. *Mund Kiefer Gesichtschir* 9(5):336-40, 2005.
62. Meneghini F, Castellani A, et al, Metastatic chordoma to the mandibular condyle: an anterior surgical approach. *J Oral Maxillofac Surg* 60(12):1489-93, 2002.
63. dos Santos DT, Cavalcanti MG, Osteosarcoma of the temporomandibular joint: report of two cases. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 94(5):641-7, 2002.

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Cone Beam Computed Tomography: Evaluation of Maxillofacial Pathology

MANSUR AHMAD, BDS, PHD, AND EARL FREYMILLER, DMD, MD

ABSTRACT CBCT scans are increasingly used in evaluating osseous pathology in the maxillofacial skeleton, e.g., cysts, benign and malignant tumors, inflammatory conditions, paranasal sinus disorders, and soft-tissue calcifications. The authors discuss the diagnostic benefits and limitation of CBCT images compared to other imaging methods. CBCT scans provide superior diagnostic information compared to panoramic radiographs. In most maxillofacial diagnostic and surgical planning or follow-up needs, CBCT scans can replace multidetector CT scans.

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With the introduction of cone beam computed tomography, the diagnosis of orofacial conditions has significantly improved in the last decade. Some of the major uses of CBCT examination include implant planning, identification of inferior alveolar canals, and evaluation of the temporomandibular joints. CBCT examinations are also frequently used in the diagnosis of lesions appearing in the maxillofacial structures. This paper provides some of the evidence and examples of the benefits and limitations of CBCT in diagnosing maxillofacial disease. The paper also provides recommendations for ordering a CBCT scan in situations where the diagnostic benefits are most likely.

Traditionally, radiographic analysis of large lesions in maxillofacial structures is accomplished with panoramic radiography. Limitations of panoramic radiography include variable magnification, distortion, superimposition of structures, and reliably recording only structures located in the focal trough, CBCT images are superior to panoramic radiography in all these aspects. Depending on the field of view, a CBCT scan images a large area of the facial skeleton beyond the limits of a panoramic radiograph (**FIGURE 1**), or a small area of focused clinical interest. As the CBCT slices can be reformatted and viewed in multiple possible orientations (multiplanar views), anatomic structures are not superimposed.[1]

Prior to the introduction of CBCT, multiplanar views were created primarily with multidetector CTs, MDCT, and magnetic resonance imaging, MRI. Physical dimensions and cost of MDCT and MRI equipment are prohibitive for installation in a typical dental office.

FIGURE 1. Fibrous dysplasia in an asymptomatic patient presenting for orthodontic treatment. Data acquired using an iCAT CBCT machine. Images are reformatted in iCATVision software. **(A)** Axial view at the level of the orbits shows fibrous dysplasia posterior to the right orbit and constriction of the optic canal (arrow). **(B)** Coronal view at the level of sphenoid sinus shows the fibrous dysplasia is encroaching into the middle cranial fossa. This fibrous dysplasia was not detected on panoramic radiograph.

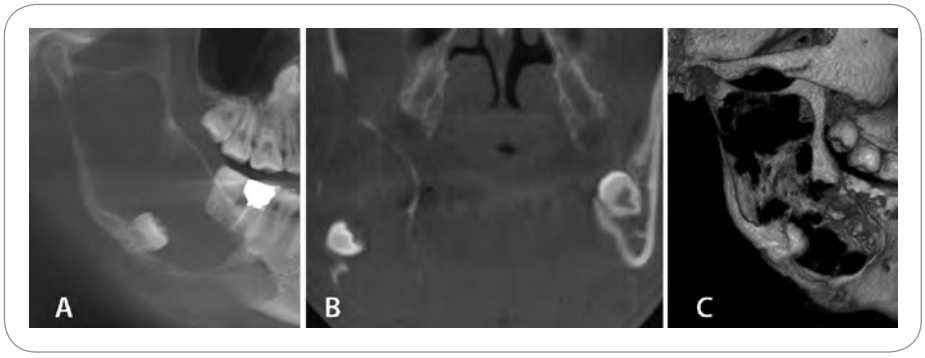

FIGURE 2. Ameloblastoma. An 18-year-old male. Data acquired using an iCAT CBCT machine. Images are reformatted in OnDemand 3-D, a third-party software. **(A)** Sagittal view of the right mandible showing a large multilocular lesion and inferior displacement of the third molar. **(B)** Coronal section through the angle of the mandible. Compared to the normal left side, the right side shows expansion in buccolingual aspect and lower border of the mandible. The third molar is next to the buccal cortical plate. **(C)** A 3-D reconstruction of the involved area, showing the thinning and perforation of the cortical plates. The superimposing structures (vertebra, hyoid bone) are subtracted by segmentation.

Smaller physical dimensions, lower cost, and easier operation have led to rapid acceptance of CBCT units in dental offices. In many situations, CBCT scans are a valid alternative to MDCT scans. However, the need of MDCT and MRI examinations in dentistry is not obsolete. Dentists who have been using MDCT scans, may find the quality of CBCT images equal or better.[2] Previously, when MDCT scans were delivered on a printed film sheet, the dentist had no capacity to reformat the image in any other orientation or convert the data into a 3-D surface model.

More recently, the ordering dentists receive a MDCT scan on a CD from a hospital. Such a CD usually contains a basic version of the image viewing software, with only limited ability to generate 3-D models. Reviewing the maxillofacial skeleton and relationship of the dental arches in 3-D models has high diagnostic value. Several CBCT manufacturers provide free software to reconstruct 3-D models. These 3-D surface models generated from CBCT data may be slightly inferior to that from MDCT, but are usually of acceptable quality.[3]

In MDCT, the images are obtained by a series of rotations of the radiographic tube. CBCT images are obtained using rectangular or cone-shaped X-ray beam centered on a 2-D sensor, and are obtained in a single rotation around the patient's head. The single rotation of the CBCT units reduces the scan time and also the radiation dose to the patient. The image quality of the CBCT machines depends on the scanning protocols, reconstruction settings, and also on the equipment.[2,4] A study that evaluated the image quality of bone structures acquired by five different CBCT machines and one MDCT machine showed that the image quality of one CBCT machine was superior to that from MDCT machine while images from other CBCT units were comparable to MDCT images.[2] However, soft tissues are still better displayed on MRI and soft-tissue window MDCTs. Currently, neither MDCT nor CBCT can replace the MRI where soft-tissue diagnosis is the primary aim. These situations include analysis of soft-tissue tumors, extension of intraosseous tumors into surrounding soft-tissue, and position of the disc in temporomandibular joints.

In most clinical situations where a MDCT scan is likely to provide diagnostic information, a CBCT scan can be a reliable alternative. The following subsections provide recommendations for using CBCT in different maxillofacial disorders.

Use of CBCT for Benign Lesions and Cysts

One of the primary benefits of CBCT is its capacity to display the scanned area in multiplanar orientation. In evaluating cysts or benign tumors, a single, intraoral radiograph may not fully record the supero-inferior and mesiodistal dimensions of the lesion. Thus, multiple intraoral radiographs or a panoramic radiograph are often exposed. These multiple radiographs still show only the two dimensions of the lesion. Observation of the third dimension, i.e., buccolingual extension of a lesion, requires additional radiographs obtained

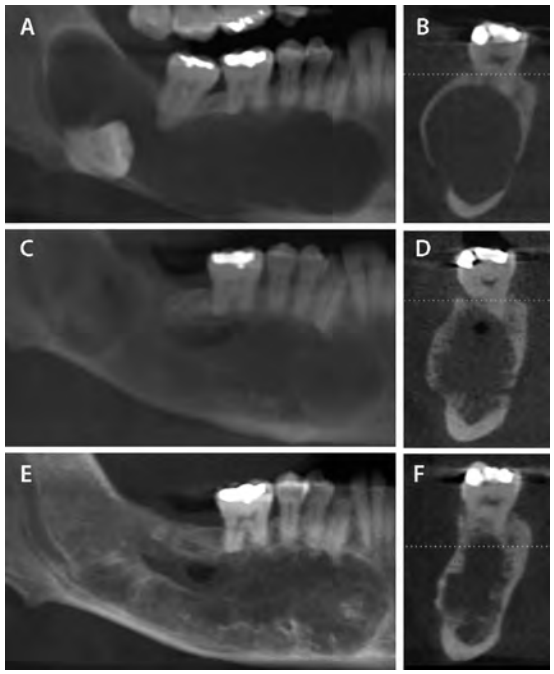

FIGURE 3. Follow-up of a keratocystic odontogenic tumor (OKC). Data acquired using an iCAT CBCT machine. Images are reformatted in iCATVision software. **(A)** Presurgical scan showing a large lesion in the right mandibular body and inferior displacement of the third molar. **(B)** Presurgical coronal view through the first molar area shows significant buccal expansion and localized thinning. **C** and **D** are eight months postsurgical. **(C)** Second and third molars were removed and lesion was marsupialized. **(D)** Eight-month postsurgical coronal view through the first molar area shows lesser expansion of the buccal cortical plate compared to the presurgical view. Note new bone formation on the inner aspect of the cortical plates. E and F are 20 months postsurgical. **(E)**The cavity has increased density, indicating almost uniform osseous healing. The surgical window is visible distal and inferior to the first molar. **(F)** Twenty-month postsurgical coronal view through the first molar area shows substantial reduction in the buccal expansion of the lesion. The cortical bones are thicker compared to that on the presurgical scan.

at 90 degrees from the original view.

In contrast, all three dimensions are recorded by multiplanar CBCT imaging. Such multiplanar views provide important information on the presence and extent of bone resorption, sclerosis of neighboring bone, cortical expansion, and internal or external calcifications.[5] Multiplanar sections (axial, coronal, and sagittal planes) are preferred when examining cysts or tumors deep in the tissues.[6] Alternatively, 3-D reconstructions are most useful for morphological analysis and spatial relationship of the neighboring structures for growth and developmental anomalies, gross tumor development, or fracture displacement[6,7] (**FIGURE 2**). Clinicians can depend on panoramic radiography for 2-D information if the margins of a cystic or benign lesion are well-defined.[8] If the margins are ill-defined, CBCT is a better option for diagnosis.[9]

From a surgical perspective, this is especially important when evaluating potential areas of cortical perforation of aggressive benign cysts or tumors (e.g., OKCs or ameloblastomas).

As a general surgical rule, where the lesions perforate the cortical bone, the resection should include the next anatomic plane (i.e., periosteum). Accurate presurgical knowledge of areas of perforation or extreme thinning of the cortex affords the surgeon the necessary information for planning the point in the dissection of an intrabony lesion, at which a supraperiosteal dissection is required and where subperiosteal dissection is acceptable.

Apart from presurgical evaluation of aggressive benign cysts or tumors, CBCT is also helpful in postsurgical follow-up of lesions that may have a high recurrence rate (**FIGURE 3**). Any new expansion or destruction of the cortical plates in the follow-up images can alert the radiologist and the surgeon of possible recurrence.

Multiple extraoral plain film radiographs, oriented at 90 degrees to each other, can provide adequate information of the size of a lesion, if the borders can be visualized. Information on the spatial relationship of the lesion with other anatomic landmarks on such images is limited, and often difficult to interpret. Because of superimposition of large tissue volume, extraoral plain film radiographs often cannot provide reliable information on the internal structure of a lesion. Multiplanar views provide superior visualization of the size and extent of the lesion with respect to the internal and neighboring critical structures.[10] Such information is essential for surgical planning (**FIGURE 4**). In the case of a maxillary ameloblastoma, the exact dimensions and its encroachment into critical structures may be better viewed on MRI.[11]

Some other benefits of CBCT are accuracy in measurement and lack of image distortion. For surgical planning, a lesion may need to be measured from different angles of viewing. For osseous components, when compared to gold standard dry skull, the measurements on CBCT images are acceptably accurate with less than 1 percent error.[12,13] In comparison, images on panoramic radiographs are easily distorted due to errors in patient positioning and are not reliable for size measurement.[14]

Use of CBCT for Malignant Lesions

Early detection of malignant lesions is of paramount importance; however, it can be difficult using plain films. Small lesions that can be "hidden" by superimposed dense tooth structures can be clearly identified on a CBCT scan (**FIGURE 5**). MDCT images can also provide information in the early stages of a malignant lesion. The advantage of CBCT over MDCT lies in the lower radiation dose and low cost.[15] Whenever a malignancy is suspected to involve osseous components, cross-sectional imaging with MDCT or CBCT must be obtained. If the lesion originates in soft tissues, only MDCT or MRI is indicated as CBCT can only be useful for evaluating any bone erosion. If a malignancy is likely to be

FIGURE 4. Calcifying odontogenic cyst involving anterior maxilla. Data acquired using an iCAT CBCT machine. Images were reformatted in iCATVision software. **(A)** Axial view shows resorption of the hard palate and presence of calcified entity (arrow). **(B)** Reformatted panoramic view shows the mesiodistal dimension of the lesion, but does not show presence of two inversely impacted teeth as viewed on **C**, **D**, and **E**.

FIGURE 5. Gingival squamous cell carcinoma in the region of tooth No. 27. A and B were acquired using Accuitomo 3-D CBCT machine. Images were reformatted in One Data Viewer. **(A)** Axial sections through cervical region of tooth No. 27 shows expansion and thinning of the buccal cortical plate (arrow). **(B)** Coronal section through tooth No. 27 shows expansion and thinning of the buccal cortical plate (arrow). **(C)** Sectional panoramic radiograph shows only a small horizontal bony defect near the cervical region of No. 27.

metastatic in nature, other examinations, such as scintigraphy, are needed. Multiple examinations using CBCT, MDCT, MRI, or nuclear medicine may be needed for a complete diagnostic work-up of a patient. The referring dentist should consult with an oral and maxillofacial radiologist to identify the appropriate examinations.

Small lesions on cortical bone, such as mucoepidermoid carcinoma on the hard palate, are difficult to diagnose using panoramic or occlusal radiographs. If clinical examination suggests such a lesion, a small field of view CBCT scan can reveal the extent of the tumor (**FIGURE 6**).

Use of CBCT for Inflammatory Changes in the Bone

Features of malignancy and osteomyelitis can look similar on plain radiography and can lead to a difficult diagnosis. On plain radiographs, malignant lesions and osteomyelitis both show irregular margins, which is an important diagnostic feature. A malignant lesion is less likely to develop a new layer of periosteal bone, while chronic infection frequently results in such layering. Periosteal reaction (**FIGURE 7**) and cortical destruction, as viewed on multiplanar images, can be useful in differentiating these radiographically similar lesions of widely different prognosis.[16]

If the infection is acute, neither plain film radiography nor CBCT scan is useful, since early infection does not cause enough bony change to be radiographically detectable. If an aggressive infection persists for two weeks or more, the primary finding on any radiographic examination is a lytic lesion with irregular margins. If the infection is chronic or moderate to low grade, the bone appears of mixed density. As a defense mechanism, the body walls the infection off by depositing layers of periosteal bone. Additionally, the margin of a chronic infection is often sclerotic and can be adequately viewed on plain film radiographs. To identify periosteal bony reactions, dentists traditionally used occlusal radiographs. However, incorrect exposure factors or angulation can limit the utility of an occlusal film to demonstrate a thin periosteal bony layer. With CBCT images, diagnosing new periosteal bone formation resulting from osteomyelitis is easier since the thin bone layer can be viewed by changing image orientation and adjusting density and contrast. From a surgical perspective, when compared with plain film, CBCT is better able to manifest small bony sequestra associated with osteomyelitis, which requires surgical debridement.

Features of osteomyelitis are also seen in bisphosphonate-related osteonecrosis of the jaws, ONJ (**FIGURE 8**). In evaluating ONJ, multiplanar images by CT and MRI are better than panoramic radiography. Currently, all these imaging modalities have limited values in detecting early stages of the disease.[17,18] Since ONJ progresses rapidly and the management of this disease is difficult, a reliable and efficient imaging protocol should be developed. Recent recommendations by the American Association of Oral and Maxillofacial Surgeons should be followed to diagnose and manage ONJ. The current recommendation is available at aaoms.org/docs/position_papers/bronj_update.pdf.

Use of CBCT for Diseases of Paranasal Sinuses

Currently, a few CBCT manufacturers are marketing their units to otorhinolaryngologists as an efficient in-office imaging tool. The benefit of using a CBCT in an ENT office is to identify less-complicated disease conditions quickly, cheaply, and

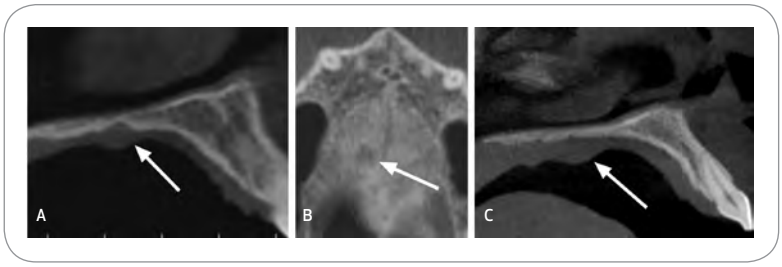

FIGURE 6. Mucoepidermoid carcinoma of the hard palate. Data acquired using an iCAT CBCT machine. Images were reformatted in iCATVision software. **A** and **B** are from the same patient. Arrows show areas of the tumor. Arrows on panels **A** and **C** show small soft-tissue growth. Arrow in panel **B** shows small area of bone resorption.

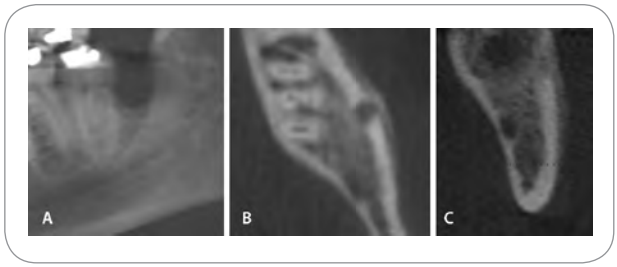

FIGURE 7. Osteomyelitis following third molar extraction. Data acquired using an iCAT CBCT machine. Images were reformatted in iCATVision software. **(A)** Reformatted panoramic view shows sclerosis of bone distal to the socket of No. 17. **(B** and **C)** Axial and coronal sections through the area of No. 17 show disruption of the buccal cortical plate and periosteal new bone formation.

with lower radiation dose compared to a MDCT examination. In many situations, an ENT specialist obtains adequate information on a CBCT scan to render a diagnosis. CBCT scans are also used to select cases that need further examinations.

For a dentist, identifying the condition of the maxillary sinuses is important for implant planning, endodontic therapy, and also to rule out sinus disease as a cause for orofacial pain. Sinusitis, a common inflammatory disease involving the maxillofacial skeleton, is often of odontogenic origin.[19,20] In some cases with sinusitis, endodontic therapy of the offending tooth may fail, requiring surgical intervention.[21] If sinusitis originates from the first maxillary molar, the periapical lesion is associated with the palatal root in 53 percent of cases.[22] If the causative tooth is a second molar, a periapical lesion of the mesiobuccal root causes the highest occurrence (60 percent). CBCT not only provides diagnostic information of the status of extension of periapical lesions into the maxillary sinuses, but also provides reliable information on the septa of the sinus and presence of exostoses. This is useful presurgical information when planning sinus floor augmentation in preparation for implant placement.[23] For the purpose of diagnosing sinus disease, altering the scan time is not required. A long acquisition time may provide better image quality and less noise compared to a short scan, but the images appear to have similar diagnostic value.[24]

Prior to the availability of multiplanar imaging, the Waters' sinus view was the most common radiographic examination for identifying sinus disorders. Studies show that Waters' sinus views are inadequate in detecting maxillary sinus opacification, and "very poor" in detecting masses in the ethmoid, frontal, and sphenoid sinuses.[25,26] These studies recommend the use of a low-dose and high-resolution multiplanar examination to evaluate the sinuses.[25] CBCT images are also helpful in identifying mucous retention phenomena, antral polyps, sinonasal polyposis, and malignant tumors of the sinuses (**FIGURE 9**). In addition, a dentist should consider a CBCT scan if there is a suspicion of oroantral fistula formation or if an implant is displaced into the sinus.

A limitation of CBCT is its poor resolution of soft tissues.[27] Sinus masses can be composed of different types of soft tissues with or without fluid accumulation. In addition, the fluid may be a thin watery secretion, blood, or a purulent mixture. On a CBCT scan, a mass in the sinus usually has a uniform density. Therefore, differentiation of the density into a fluid or soft-tissue mass is often not reliable. CBCT data can be relied on for the size and margin of the sinus mass, status of the sinus wall, and blockage of the ostium. Some software allows accurate measurement of the air space.[28,29] Fungal sinusitis often accumulates calcified materials. On a CBCT scan, these calcified materials can be easily differentiated from the soft-tissue component of the sinusitis.

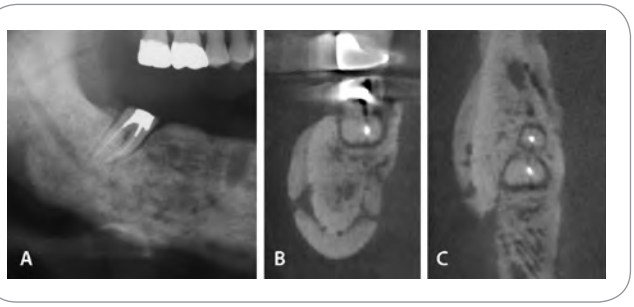

FIGURE 8. Bisphosphonate-related osteonecrosis of the jaws. B and C were acquired using J. Morita CBCT machine. Images were reformatted in One Data Viewer. (A) Section of a panoramic radiograph showing sclerotic mandibular bone with discrete radiolucencies. (B) Coronal section thorough mandibular second molar. Note prominent periosteal new bone formation around the body of the mandible with localized disruption. The bone is sclerosed with indistinguishable trabecular pattern. (C) Axial section of the mandible. Note prominent dense periosteal bone formation on the buccal aspect.

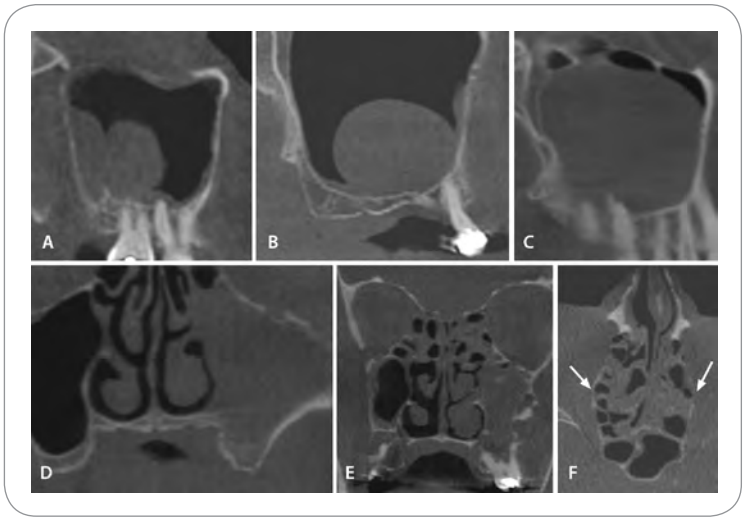

FIGURE 9. Disease of the maxillary sinuses. Data acquired using an iCAT CBCT machine. Images were reformatted in iCATVision software. **(A)** Sagittal view of maxillary sinus showing antral polyps. **(B)** Sagittal view of maxillary sinus showing retention phenomenon. **(C)** Sagittal view of maxillary sinus showing mucocele. **(D)** Coronal view of maxillary sinus showing non-Hodgkin's lymphoma. Panels E and F are from the same patient. **(E)** Coronal view of the maxillary sinuses showing sinonasal polyposis. Note prominent destruction of the lateral wall of the left maxillary sinus. **(F)** Axial view through ethmoid air cells. Note lateral expansion (arrows) of the ethmoid walls and intact septa of the air cells.

Use of CBCT in Detecting Foreign Bodies in the Maxillofacial Complex

Compared to CBCT images, MDCT images have superior soft-tissue resolution. In the maxillofacial area, the soft-tissue information on a MDCT scan can be degraded by artifacts arising from metal restorations. Extensive bridgework can make a MDCT scan virtually nondiagnostic. Such artifacts from metal objects are lower on CBCT images.[30] Therefore, a CBCT is a better imaging modality to assess metal fragments in the face, such as fragments embedded from a gunshot, automobile or industrial accidents, and for localizing retained broken dental needles.[30,31]

Use of CBCT Scans in Soft-Tissue Calcifications

Although CBCT images have low contrast (soft-tissue) resolution, they can be better than MDCT in depicting soft-tissue calcifications, such as carotid athrosclerosis[27] (**FIGURE 10**). Other calcifications, such as tonsilloliths and sialoliths, are adequately viewed on CBCT images. Small calcifications, which can be important diagnostic clues for some types of cysts and tumors, (e.g., CEOT or Pinborg tumor, COC or Gorlin cyst) are easier to identify on a CBCT scan than panoramic or intraoral radiographs.

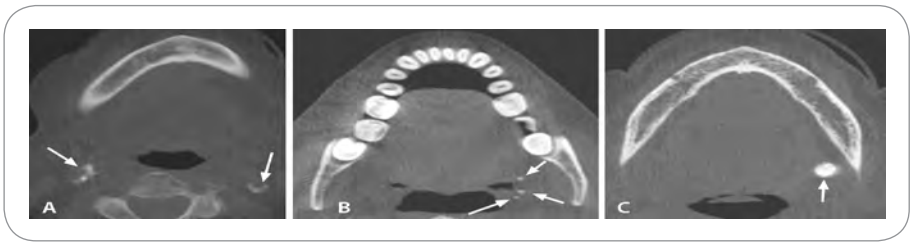

FIGURE 10. Calcifications in the soft tissues in the neck area. Data acquired using an iCAT CBCT machine. Images were reformatted in iCATVision software. **(A)**Axial section shows bilateral calcified carotid atheromas with irregularly curved margins. **(B)** Axial section shows discrete tonsillar calcifications. **(C)** Axial section shows a well-defined sialolith in the submandibular gland.

Conclusion

In the last decade, CBCT has become an important diagnostic tool for the dentists, oral and maxillofacial surgeons and otolaryngologist. The benefit of this imaging modality can be better utilized by realizing its capacities and limitations. As the technology now stands, with respect to evaluating maxillofacial disease, CBCT is mostly a tool for diagnosing diseases of the osseous structures. Currently, it is not useful for study of lesions limited to soft-tissue. When a lesion in question needs further evaluation, consultation with a trained oral and maxillofacial radiologist may be extremely beneficial. A thorough and knowledgeable interpretation is necessary to extract the extensive information available in the CBCT data set. ■■■■

REFERENCES

1. Angelopoulos C, Thomas SL, et al, Comparison between digital panoramic radiography and cone beam computed tomography for the identification of the mandibular canal as part of presurgical dental implant assessment. *J Oral Maxillofac Surg* 66:2130-5, 2008.
2. Liang X, Jacobs R, et al, A comparative evaluation of cone beam computed tomography (CBCT) and multislice CT (MSCT) Part I. On subjective image quality. *Eur J Radiol* April 2009.
3. Liang X, Lambrichts I, et al, A comparative evaluation of cone beam computed tomography (CBCT) and multislice CT (MSCT). Part II: on 3-D model accuracy. *Eur J Radiol* May 2009.
4. Loubele M, Guerrero ME, et al, A comparison of jaw dimensional and quality assessments of bone characteristics with cone beam CT, spiral tomography, and multislice spiral CT. *Int J Oral Maxillofac Implants* 22:446-54, 2007.
5. Kaneda T, Minami M, Kurabayashi T, Benign odontogenic tumors of the mandible and maxilla. *Neuroimaging Clin N Am* 13:495-507, 2003.
6. Yuan XP, Xie BK, et al, Value of multislice spiral CT with 3-D reconstruction in the diagnosis of neoplastic lesions in the jawbones. *Nan Fang Yi Ke Da Xue Xue Bao* 28:1700-2, 1706, 2008.
7. Cavalcanti Mde G, Antunes JL, Three-D-CT imaging processing for qualitative and quantitative analysis of maxillofacial cysts and tumors. *Pesqui Odontol Bras* 16:189-94, 2002.
8. Chuenchompoonut V, Ida M, et al, Accuracy of panoramic radiography in assessing the dimensions of radiolucent jaw lesions with distinct or indistinct borders. *Dentomaxillofac Radiol* 32:80-6, 2003.
9. Araki M, Kameoka S, et al, Usefulness of cone beam computed tomography for odontogenic myxoma. *Dentomaxillofac Radiol* 36:423-7, 2007.
10. Hashimoto K, Sawada K, et al, Diagnostic efficacy of 3-D images by helical CT for lesions in the maxillofacial region. *J Oral Sci* 42:211-9, 2000.
11. Kawai T, Murakami S, et al, Diagnostic imaging in two cases of recurrent maxillary ameloblastoma: comparative evaluation of plain radiographs, CT and MR images. *Br J Oral Maxillofac Surg* 36:304-10, 1998.

12. Ludlow JB, Laster WS, et al, Accuracy of measurements of mandibular anatomy in cone beam computed tomography images. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 103:534-42, 2007.
13. Stratemann SA, Huang JC, et al, Comparison of cone beam computed tomography imaging with physical measures. *Dentomaxillofac Radiol* 37:80-93, 2008.
14. Batenburg RH, Stellingsma K, et al, Bone height measurements on panoramic radiographs: the effect of shape and position of edentulous mandibles. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 84:430-5, 1997.
15. Closmann JJ, Schmidt BL, The use of cone beam computed tomography as an aid in evaluating and treatment planning for mandibular cancer. *J Oral Maxillofac Surg* 65:766-71, 2007.
16. Ida M, Tetsumura A, et al, Periosteal new bone formation in the jaws. A computed tomographic study. *Dentomaxillofac Radiol* 26:169-76, 1997.
17. Bianchi SD, Scoletta M, et al, Computerized tomographic findings in bisphosphonate-associated osteonecrosis of the jaw in patients with cancer. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 104:249-58, 2007.
18. Stockmann P, Hinkmann FM, et al, Panoramic radiograph, computed tomography or magnetic resonance imaging. Which imaging technique should be preferred in bisphosphonate-associated osteonecrosis of the jaw? A prospective clinical study. *Clin Oral Investig* June 2009.
19. Bomeli SR, Branstetter BFt, Ferguson BJ, Frequency of a dental source for acute maxillary sinusitis. *Laryngoscope* 119:580-4, 2009.
20. Brook I, Sinusitis of odontogenic origin. *Otolaryngol Head Neck Surg* 135:349-55, 2006.
21. Selden HS, The endoantral syndrome: an endodontic complication. *J Am Dent Assoc* 119:397-8, 401-392, 1989.
22. Maillet M, Cone beam computed tomographic evaluation of maxillary sinusitis of odontogenic origin. Division of Endodontics, vol. MS. Master's thesis: University of Minnesota, 2008.
23. Naitoh M, Suenaga Y, et al, Assessment of maxillary sinus septa using cone beam computed tomography: etiological consideration. *Clin Implant Dent Relat Res* May 2009.
24. Zoumalan RA, Lebowitz RA, et al, Flat panel cone beam computed tomography of the sinuses. *Otolaryngol Head Neck Surg* 140:841-4, 2009.
25. Konen E, Faibel M, et al, The value of the occipitomental (Waters') view in diagnosis of sinusitis: a comparative study with computed tomography. *Clin Radiol* 55:856-60, 2000.
26. Aalokken TM, Hagtvedt T, et al, Conventional sinus radiography compared with CT in the diagnosis of acute sinusitis. *Dentomaxillofac Radiol* 32:60-2, 2003.
27. Heiland M, Pohlenz P, et al, Cervical soft-tissue imaging using a mobile CBCT scanner with a flat panel detector in comparison with corresponding CT and MRI data sets. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 104:814-20, 2007.
28. Osorio F, Perilla M, et al, Cone beam computed tomography: an innovative tool for airway assessment. *Anesth Analg* 106:1803-7, 2008.
29. Yamashina A, Tanimoto K, et al, The reliability of computed tomography (CT) values and dimensional measurements of the oropharyngeal region using cone beam CT: comparison with multidetector CT. *Dentomaxillofac Radiol* 37:245-51, 2008.
30. Stuehmer C, Essig H, et al, Cone beam CT imaging of airgun injuries to the craniomaxillofacial region. *Int J Oral Maxillofac Surg* 37:903-6, 2008.
31. von See C, Bormann KH, et al, Forensic imaging of projectiles using cone beam computed tomography. *Forensic Sci Int* 190(1-3):38-41, 2009.

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Legal Considerations in the Use of Cone Beam Computer Tomography Imaging

EDWIN J. ZINMAN, DDS, JD; STUART C. WHITE, DDS, PHD; AND SOTIRIOS TETRADIS, DDS, PHD

ABSTRACT Cone beam computed tomography imaging represents a paradigm shift for enhancing diagnosis and treatment planning. Questions regarding cone beam computed tomography's associated legal responsibility are addressed, including cone beam computed tomography necessity, recognition of pathosis in the scan's entire volume, adequate training, informed consent and/or refusal and current court status of cone beam computed tomography. Judicious selection and prudent use of cone beam computed tomography technology to protect and promote patient safety and efficacious treatment complies with the standard of care.

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Cone beam computed tomography, CBCT, technology was introduced to the dental profession more than a decade ago. It offers a new means of visualizing the orofacial complex to provide valuable diagnostic and treatment planning information for the dental patient. Indeed, in multiple applications of everyday dental practice, CBCT enhances diagnostic accuracy of disease detection, reveals anatomic structures that complicate treatment or allows confident identification of anatomic variants that simulate disease but do not require intervention. An increasing number of publications supporting CBCT use and the availability of CBCT scanners in universities, private dental offices and dental radiographic laboratories has facilitated the availability of CBCT imaging for the diagnosis and treatment planning of the dental patient. It can be argued that in many ways CBCT technology has transitioned from a paradigm shift in orofacial imaging to a standard of care for dental practice for diagnosing or managing some conditions.[1]

California courts define the standard of care as that level of skill, knowledge, and care that a reasonably careful dentist should possess and use for diagnosis or treatment.[2] Reasonably careful dentists comply with the standard of care in using CBCT to maximum advantage for diagnostic accuracy in radiographic interpretation and treatment planning.

In conjunction with the advantages and opportunities from the application of new technologies in patient care, responsibilities and obligations for proper use of such technologies also emerge. Pertinent legal questions and answers for CBCT technology are categorized below in questions involving diagnosis, training, utilization, and patient involvement.

Diagnosis

Q: Is a dentist legally obligated to recognize or diagnose all disease evident in a CBCT examination if it is not in the field of interest for which the CBCT was ordered?

A: Multiple dentists and dental organizations have expressed the belief that similar to conventional radiographs, the responsibility of the clinician is not limited to only the field of interest being diagnosed and/or treated. As recommended in a leading dental radiology textbook, "Practitioners should avoid limiting their attention to one particular region of the film, all aspects of each film should be examined systematically."[3] The executive board of the American Academy of Oral and Maxillofacial Radiology, AAOMR, the professional organization representing oral and maxillofacial radiologists in the United States, recommends that dentists should be competent to identify abnormalities and suspicious areas of pathosis existent in the entire CBCT scan or refer the images to a specialist for final interpretation.[4] The American Association of Orthodontist's Council on Scientific Affairs surveyed various university-based radiology departments and concurs with the AAOMR's executive committee's conclusion that a CBCT scan should be read in its entirety.[5]

There are several legal perspectives to this question. First, is the treating dentist legally responsibility to recognize and/or diagnose disease in the structures that fall within the scope of the dentist's license as defined by the California Dental Practice Act but outside the dentist's area of interest[6]? The California Dental Practice Act defines dentistry to include "diagnosis or treatment, by surgery or other methods of disease and lesions" of the "jaws or associated structures."[7] Accordingly, such diagnosis or treatment may include all necessary related procedures that may include a CBCT as an "other method" of diagnosing disease in "associated structures." **FIGURES 1A-D** illustrates an unanticipated incidental finding of metastatic malignancy in the anterior maxilla detected in an asymptomatic implant patient. This finding completely changed the treatment planning of the patient.

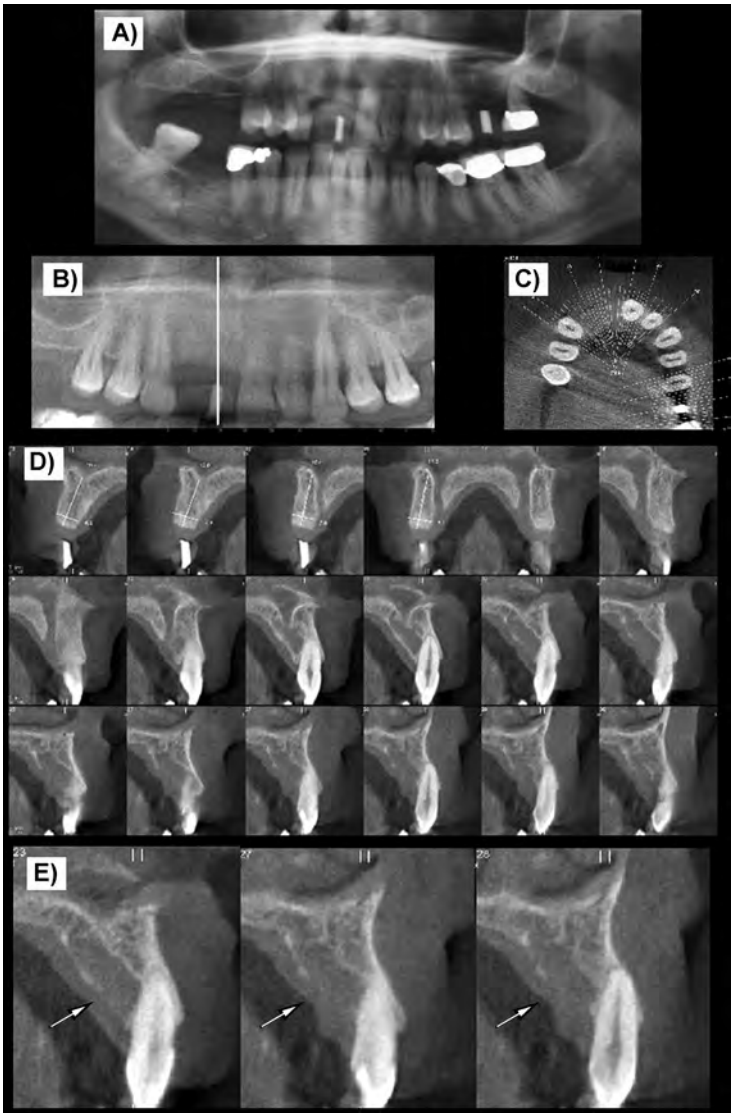

FIGURE 1. (A) Cropped conventional panoramic radiograph of patient A, prior to implant placement. Two radiopaque markers at the areas of prospective implants are in place. **(B)** "Panoramic" CBCT reconstruction showing the opaque marker at the area of the anterior maxilla. **(C)** An axial slice through the maxillary teeth showing the position and number of transaxial slices through the implant areas. **(D)** A series of transaxial slices through the area of teeth Nos. 8-10. Bone width and height measurements at the area of the marker demonstrate sufficient quantity and adequate quality for implant placement. Adjacent to the marker and lingual to teeth Nos. 9 and 10 an irregular radiolucency is observed. There is erosion of the palatal cortex of the maxilla with no tooth displacement and minimal bone expansion. **(E)** Selected magnified transaxial sections through the area of the lesion. This radiographic presentation is consistent with malignant disease or infection. Biopsy of the lesion demonstrated metastatic malignancy of unknown origin.

Second, is it within the scope of the dentist's license to recognize and/

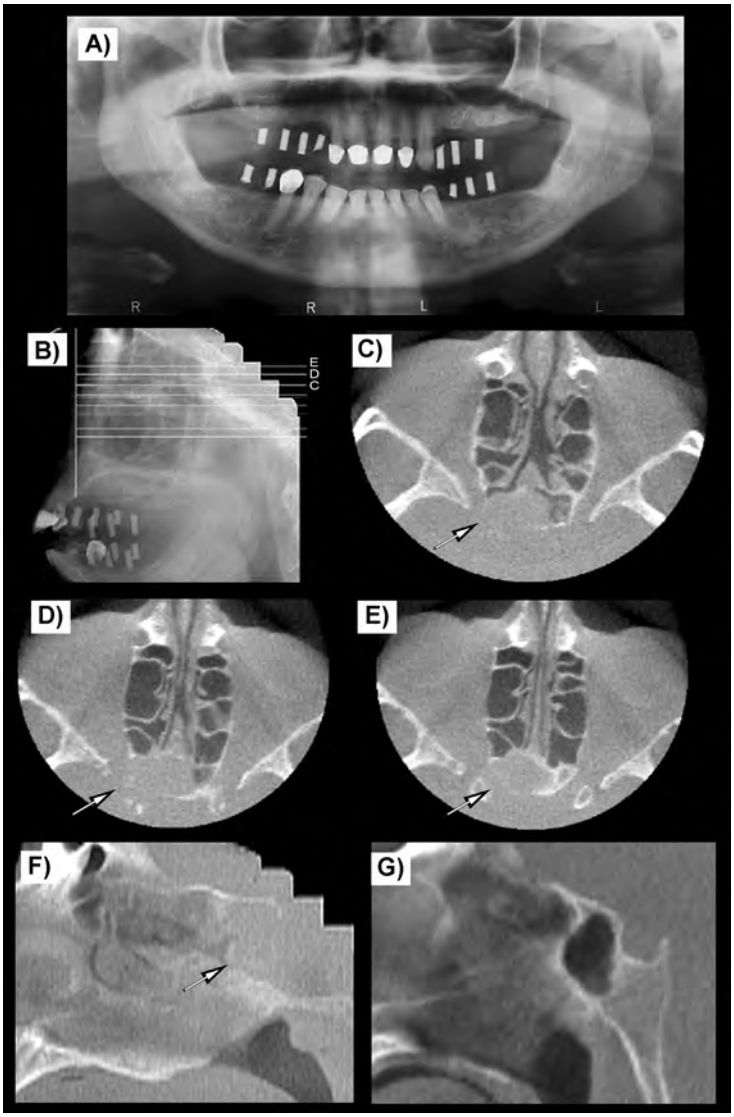

FIGURE 2. **(A)** Conventional panoramic radiograph of patient B prior to implant placement. Twelve radiopaque markers at the areas of prospective implants are in place. The facial structures are unremarkable. **(B)** Detail of scout view from CBCT. The radiopaque markers are seen at the area of the jaws. The position of axial slices through the midface and base of the skull area is marked. **(C, D** and **E)** Three representative axial slices through the base of the skull. Note opacification of the sphenoid sinus and destruction of the sphenoid sinus walls and floor of the sella turcica (arrows). **(F)** Sagittal slice at the midline, through the skull base. Destruction of the sella turcica and complete opacification of the sphenoid sinus are seen (arrow). **(G)** Sagittal slice at the midline, through the skull base of a normal individual is provided for comparison with **(F)**. The lesion in patient B was subsequently determined to be a pituitary gland tumor.

or diagnose pathosis outside the dental alveolar complex? The answer to this question has not yet been definitively decided by a California appellate court. In the interim, it is a general legal principle to always prudently err on the side of caution and presume a dentist is obligated to recognize pathosis in the entirety of the CBCT scan as peer-reviewed literature recommends.[4,5,8,9]

FIGURES 2A-F illustrate such a case where a pituitary tumor causing destruction of the sella turcica and sphenoid sinus was discovered as an unexpected incidental finding in the CBCT scan of an implant patient. As with the malignancy in **FIGURE 1**, a dentist would not be required to diagnose the pituitary tumor as the cause of the destruction but rather recognize a suspected abnormality or pathosis, which mandates referral for final diagnosis and any needed treatment.

Moreover, full-volume scan assessment is in accord with dentistry's paramount ethical obligation to always protect the patient's best interest to preserve patient health and safety.[10] Consultation with specialists, such as oral and maxillofacial radiologists, oral and maxillofacial surgeons, oral pathologists, or medical specialists as warranted can aid in this task.[11] Clinical findings, as well as pertinent medical and dental history, are useful to help evaluate CBCT examination findings and should be included when a referral to a specialist is made to aid a CBCT interpretation. Peer-reviewed literature and numerous dental specialties who support the concept that a dentist must identify suspicious conditions within the entirety of a CBCT scan may provide the greater weight of expert opinion to any future court ruling that a dentist practices within the scope of the practitioner's dental license when identifying abnormalities in the CBCT's scan entire volume and/or referring for a final diagnosis.[4,5,8,9,12,13]

Third, is the treating dentist legally responsible to identify a lesion in structures other than the orofacial complex, if this dentist is also practicing under a medical license? Although no California appellate court has ruled in such a case, the answer is probably "yes," since the medical license extends responsibility for care to these structures.

Q: Once an abnormality is identified on a CBCT, who is legally responsible to diagnose, treat, or refer this condition?

A: The responsible dentist is the one who orders the CBCT examination. For instance, suppose a generalist refers a patient to a surgical and prosthetic specialists for implant placement and prosthetic restoration. In this scenario, only the treating specialist who orders the CBCT examination is liable. If the generalist also incidentally uses the CBCT for either diagnosis or treatment planning, then the generalist may also be liable.

A general dentist's identification of disease is ordinarily a final diagnosis. This would include, for instance, an endodontic lesion necessitating root canal therapy that the generalist may treat or refer to an endodontist. However, if the generalist can only identify but not diagnose the abnormality, a referral should be made to determine a final diagnosis. By analogy, a dental hygienist is trained to recognize but not diagnose dental disease but yet must obtain a diagnosis for suspected pathosis or refer.

Q: If a treating dentist refers a CBCT scan to a board-certified oral and maxillofacial radiologist for diagnosis of the whole imaged volume and it is later determined that a lesion was detectable but missed by both, is the treating dentist protected from liability?

A: Although referring to a competent radiologist specialist to interpret a CBCT substantially reduces the likelihood of a missed finding, misdiagnoses can occur. The radiologist is principally responsible for any misdiagnosis. The fact that a radiology specialist did not identify the pathosis substantially reduces the potential liability of the referring dentist who reasonably relied upon the radiologist's specialized training and expertise.

Q: Is the treating dentist legally responsible for identifying the anatomical course of the inferior alveolar nerve canal, IANC, on a CBCT reconstruction if an X-ray lab provides a tracing or images with the outline of the IANC?

A: Yes. A dental lab technician is not legally permitted to diagnose. A dentist must either confirm or reconfigure the drawn IANC. Therefore, the X-ray lab should not only provide an estimate of the IANC course as drawn but also additionally provide the same image absent the X-ray lab's drawing. The dentist can then make the final diagnosis of the IANC location including the ascending IANC portion, mental foramen, any anterior loop of the mental nerve and anomalies such as a bifid canal. Just as the dentist is responsible for evaluating the quality of the dental lab's prosthesis prior to restoration cementation, so is the dentist responsible for identifying the precise location of vital structures within the CBCT for diagnosis and treatment planning.

Training

Q: Suppose the dentist received no training in dental school in recognizing lesions located superior or posterior to the maxillary sinus. Is the dentist still legally responsible to recognize disease outside the scope of the dentist's academic training?

A: Yes. A reasonably careful dentist must keep current with continuing education. California State Board continuing education, C.E., requirements for license renewal are only a licensing standard that does not mandate, with few exceptions, any particular C.E. credits such as dental radiology.[14] A reasonably careful dentist should keep current in all fields of dentistry in which the clinician practices and particularly when employing new technology, which requires training and skill for adequate utilization.

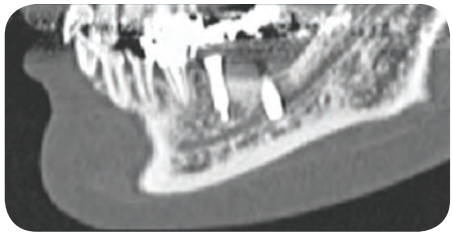

FIGURE 3. CBCT sagittal reconstruction demonstrating a dental implant penetrating through both the superior and inferior cortical borders of the inferior alveolar nerve canal.

Numerous authors increasingly opine that dentists using CBCT should be held to the same standard as a board-certified oral and maxillofacial radiologist.[5,8,9,12] By analogy, dentists extracting horizontally impacted wisdom teeth are held to the same standard as oral and maxillofacial surgeons.[13,15] Similarly, generalists are held to the same standard as an endodontist performing root canal therapy because endodontists set the standard of care in endodontics.[16]

Q: Should a general dentist use a CBCT for diagnosis or treatment planning without training?

A: No. Virtually any new sophisticated technology requires training. Also, the standard of care requires a dentist to possess a requisite degree of learning and skill.[2] A dentist cannot exercise reasonable skill and learning if the dentist does not first possess the requisite learning and skill that the standard of care requires. Learning includes not only didactic classes but also hands-on training. The third dimension of a CBCT requires training to assess moving on the computer static sequential imaging series. By analogy, a dentist should not employ laser technology or perform implant surgery without a minimum amount of hands-on training.[17] **FIGURE 3** demonstrates a case of implant placement within the IANC, seen on a postimplant placement CBCT image. Interestingly, the dentist had obtained a medical CT prior to implant placement. Apparently, these CT images were misinterpreted. As a consequence, the preoperative height of the alveolar ridge implant site was overestimated.

A dentist's legal and ethical obligation is to always protect the patient's best interest.[10,18] Instead of doing no harm (primum non nocere), an undiagnosed disease harms the patient if not treated at the earliest time since treatment delayed denies optimal therapy with improved prognosis. A dentist who acquires a CBCT and fails to assess the entire scan volume is not exercising the dentist's best judgment but rather is practicing blindly.

Q: What constitutes adequate training to interpret CBCT examinations?

A: As with any new technology, the best training is hands-on training. With CBCT, such training should not be limited to the technical issues of patient positioning, image reconstruction and multiplanar sectioning, but should expand to the recognition of normal anatomy and anatomic variants that might complicate treatment or simulate disease, as well as to the identification and interpretation of pathosis. A certificate of training is helpful to prove to a jury that the dentist achieved minimum competence to interpret CBCT scans. An example of circumstantial evidence of a gross departure from the standard of care would be that despite a preoperative CBCT the implant was placed through the entire diameter of the IANC. Indirect circumstantial evidence may infer that either the dentist's CBCT training program was inadequate or that the dentist violated the principles taught in the CBCT course. Circumstantial evidence is entitled the same weight of proof as direct evidence.[19] Alternatively, an expert may opine that such an extreme degree of IANC penetration ordinarily does not occur except for probable operator negligence.[20] This legal doctrine of res ipsa loquitur means the facts speak for themselves.

One of the defenses to dental negligence is that the dentist made a reasonable judgment error.[21] A dentist's best judgment should not be impaired because of ignorance or by failure to become current with ever improving CBCT technology.

Utilization

Q: Is every patient likely to benefit from a CBCT examination?

A: No. The dentist is obligated to determine when a CBCT is necessary to complement conventional 2-D images. Reasonable and careful judgment is a necessary prerequisite in selecting patients for any radiograph including CBCT. Only after obtaining a thorough dental and medical history and performing a detailed clinical examination, the dentist should carefully assess the necessary radiographic procedures required. Prudent practice requires the practitioner to justify radiation exposure based upon likely patient benefit exceeding ionizing radiation risk and the financial cost.[22] Optimization for radiation hygiene safety is premised on three justification principles as follows[23]:

1. Imaging will probably do more good than harm.
2. The radiological procedure will likely improve diagnosis and/or treatment.
3. Alternative imaging with less or no radiation and/or prior imaging is equivocal or unavailable.

Using a CBCT scan for screening purposes, without appropriate clinical indications, should be avoided. Unnecessary or overutilization may create conflicts of interest, particularly if a specific CBCT unit is installed in the dental office and scans are made indiscriminately. Indeed, physicians who own their own medical CT facility are five to seven times more likely to order CT scans than those who refer to outside facilities.[24] The practitioner is always obligated to protect the patient's best interest regardless of the practitioner's financial interest.[10,18] The patient is entitled to information about different options, including a discussion of conventional imaging, CBCT and CT in terms of radiation dosage, fields of view, resolution, and cost. The adequately informed patient has the ethical and legal right to make the final decision in compliance with the principle of patient autonomy.[10,25]

USING A CBCT SCAN for screening purposes, without appropriate clinical indications, should be avoided.

Q: Is the type of CBCT unit used important from a legal perspective?

A: CBCT scanners can be categorized according to the field of view, FOV, as large, medium, and small FOV units. A large FOV can include intracranial structures, the base of the skull, paranasal sinuses, cervical spine, neck, and airway. A small FOV is typically limited to the maxilla or mandible, exposes fewer anatomic structures, produces less scatter, creates fewer artifacts and in general provides a higher resolution image. Thus, the smallest FOV of a CBCT available that covers the area of interest should be chosen. (See previous articles and references within this issue of the *Journal*).

An additional benefit of using the smallest FOV scan for the diagnostic task is that fewer anatomic structures will be visualized, thus minimizing the necessity to detect any incidental abnormalities outside the area of interest. Therefore, a small FOV limits legal liability of unidentified pathosis outside the dentist's treating field of interest since such disease outside the dental alveolar complex is less likely to be depicted in the scan.

Q: Can the dentist be liable for not ordering a CBCT or other volumetric examination?

A: If conventional intraoral or panoramic radiographs provide the diagnostic information for appropriate treatment planning, CBCT imaging should not be used. However, CBCT or other 3-D evaluation should always be considered when 2-D imaging is equivocal in providing a final diagnosis. This is particularly important in cases where a treatment complication requiring immediate corrective care is suspected and/or if the patient is unresponsive to treatment.

For example, postoperative anesthesia or paresthesia eight hours following implant placement near the IANC or its anterior loop should direct the practitioner to consider a CBCT to aid in the diagnosis of any potential IANC or anterior loop penetration, if periapical or panoramic radiographs are inconclusive. Similarly, CBCT imaging can provide valuable diagnostic information in cases of persistent or enhanced pain or paresthesia after endodontic treatment or suspicion of endodontic treatment complications such as perforation, fractures, short fills, missed or apically transported root canals, and endodontic overfills into the IANC. Such complications would be difficult to evaluate accurately with 2-D imaging.

FIGURE 4 demonstrates a case of endodontic perforation with resulting sodium hypochlorite injury to the lingual gingiva (**FIGURE 4A**). A periapical image made after a root canal treatment was aborted midendodontic treatment because acute severe pain did not reveal the perforation (**FIGURE 4B**). However, the lingual perforation is clearly evident on the CBCT image (**FIGURE 4C**) and on the postextraction photographs (**FIGURE 4D**). This case demonstrated that periapical 2-D imaging did not identify endodontic perforation as the probable cause of lingual tissue sloughing, while CBCT imaging provided objective circumstantial evidence of the perforation portal of entry for irrigating bleach diffusing through the perforation lingually into the underlying tissues.

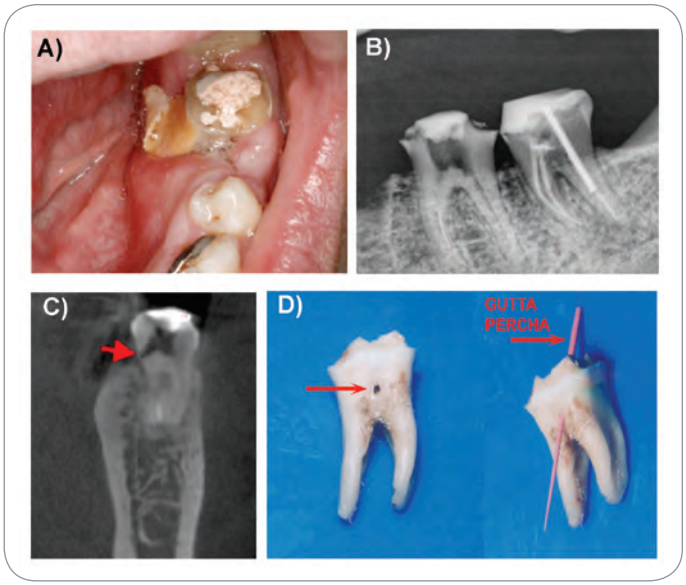

FIGURE 4. (A) Clinical picture demonstrating soft-tissue sloughing of lingual gingiva after application of sodium hypochlorite during endodontic treatment of No. 19. **(B)** Midtreatment periapical radiograph erroneously demonstrating unperforated root of No. 19. **(C)** CBCT cross-section showing perforation of the lingual surface of No. 19 at the cervical area (arrow). **(D)** After extraction of No. 19, the perforation is clearly seen (arrows). A gutta percha cone has been inserted in the perforation through the coronal surface of the tooth.

Q: Are CBCTs necessary for all implant placements?

A: The 2000 position paper from the American Academy of Oral and Maxillofacial Radiology opined that cross-sectional imaging, which today may include CBCT, before implant placement should be performed for all implants.[26] However, other experts may disagree whether CBCTs are necessary in all instances, particularly if there is a wide margin of safety distance between the proposed implant depth and vital structures along with ample ridge height and width for prosthetic alignment. Thus, reasonable dentists may have reasonable differences of opinion. Moreover, a CBCT may not be geographically accessible, although medical CTs are widely available.

There is general consensus that for implant surgery a 2 mm safety zone between the maximum implant plant drill depth and superior border of the IANC should be maintained.[27-29] A CBCT should be considered if this safety zone distance cannot be accurately estimated with 2-D imaging. With only a periapical film, the mental foramen is clearly shown only half the time and is anatomically accurate within 1 mm between the alveolar crest and the superior crest of the IANC only 17 percent of the time.[30]

CBCT is preferred over medical CT since CBCT delivers considerably less radiation and provides comparable diagnostic accuracy of bone and teeth. A medical CT's superiority for soft-tissue analysis compared with a CBCT is usually not needed for implant placement.

Should a complication arise following implant placement when a preoperative CBCT and surgical guide were not used, a CBCT may become necessary for postoperative evaluation of whether the implant is malaligned or impinging upon or penetrating into vital structures.[2] A CBCT can then aid the decision to remove or partially retract before osseointegration occurs. CBCT also aids in diagnosing cause of postoperative neuropathic pain or paresthesia including endodontic overfills into the IANC.

Patient Involvement

Q: When medical CT is chosen instead of CBCT, is informed consent regarding comparative radiation safety required?

A: If a procedure involves the risk of serious injury, a patient is entitled to be informed of these risks. Dental literature from 15 years ago stated that there was no proven biologic harm from routine dental X-rays.[31] Current literature does not exclude the possibility of harm from diagnostic exposures.[32] Imaging procedures with ionizing radiation are an important source of exposure resulting in the combined cumulative effects of natural background and ionizing radiation. The linear nonthreshold hypothesis holds that any ionizing radiation has a potential carcinogenic effect, regardless of dose level.[23,33-37]

Notwithstanding, in one study the majority of ER physicians and almost half the radiologists did not appreciate any cancer potential from CT radiation.[38] Thus, the radiation protection principle of ALARA, as low as reasonably achievable, is relevant to all radiation exposures. In the 1980s, the annual average per capita radiation dose from medical procedures was 0.54 mSv.[39] Today, it is 3.2 mSv in the United States and between 0.7 mSv and 2.0m mSv in Europe.[33] Increased use of medical CT and nuclear medicine examinations accounts for most of the increased radiation exposure. [17,23,28,31,34,35,40,41] The effective dose from CT and CBCT examinations can vary widely but typically CBCT exposures are 10 percent or less of a medical CT examination.[42]

For many common clinical applications such as implants or orthodontics, CBCTs offer diagnostic efficacy comparable to medical CT at a fraction of the exposure. For small volume issues such as endodontic, TMJ, or single-implant placement applications, high-resolution CBCT is superior to medical CT.[12] Accordingly, the patient is entitled to be informed of the CBCT's advantage over CTs for accuracy, lower radiation, and likely lower costs. Thus, a patient may elect to travel a greater distance to obtain a CBCT rather than obtain a geographically convenient CT at a closer medical CT facility. The informed consent doctrine requires the patient being advised of their options so the patient may make the final decision.[25]

Q: Is the dentist responsible if the patient refuses a specialist referral after a suspicious lesion is identified on the CBCT?

A DENTIST HAS THE right to refuse treatment if a patient refuses necessary diagnostic imaging or referral, and should do so.

A: California informed refusal law requires that the patient be informed of the consequences of their refusal.[43] The chart and also, preferably, an informed refusal form should document that the undiagnosed condition may include malignancy, life-threatening or disfiguring tumors. Most patients will probably reconsider a necessary referral rather than sign an informed refusal form that advises them of the consequences of a refusal. As an extra abundance of caution, the patient could copy the informed refusal form in their own handwriting and sign their entire name. Depending upon the patient's financial circumstances, the dentist may wish to absorb the consultation fee for a specialist's diagnosis.

A dentist has the right to refuse treatment if a patient refuses necessary diagnostic imaging or referral, and should do so. An exception may occur if the dentist is in the middle of treatment that places the dentist and patient relationship at risk of abandonment if treatment is discontinued.[44] An abandonment claim can be reduced, if not eliminated, if complete and accurate diagnostic images are obtained before initiating treatment rather than after a complication arises.

Conclusion

Dentists should use CBCT as an advanced diagnostic tool to aid diagnosis and treatment planning when indicated. The dentist should obtain hands-on learning to appreciate the diagnostic information contained in the CBCT image or refer the patient to an expert. Dentists have a legal and ethical obligation to provide and protect the patient's best interest as their primary goal in patient care.[10,18] A reasonably careful dentist complying with the standard of care should always weigh the benefits versus risks of proposed treatment. Because CBCT examinations offer substantial diagnostic benefits, low radiation harm risk and modest financial cost, the benefit/risk balance is generally in favor of making the examination when appropriate clinical indications exist.

The dentist should judiciously justify ordering CBCT scans and, when they are needed, use the smallest field of view appropriate to the task. The dentist should also consider the patient's lifetime accumulation of medical/dental X-ray dosage in accordance with reasonable and careful radiation safety precautions embodied in the ALARA principle.[41] CBCT scans should not be ordered when alternative modalities offer equal efficacy with lesser or no ionizing radiation or when they would be unnecessarily repetitive. CBCT imaging, when justified, often provides improved diagnostic information compared to conventional

imaging that can lead to significant therapeutic benefits. As a general maxim, a dentist should not be the first nor the last to adopt new technology. At this stage in the evolution of CBCT technology, a dentist will certainly not be the first nor should a dentist be the last to include CBCT among their judicious choices of diagnostic armamentarium. ■■■■

REFERENCES

1. Curley A, Hatcher DC, Cone beam CT – anatomic assessment and legal issues: the new standards of care. *J Calif Dent Assoc* 37(9):653-62, 2009.
2. California Judicial Council of California Jury Instruction (CACI) 501. Standard of Care for Health Care Professionals.
3. White S, Pharoah MJ, Oral Radiology Principles and Interpretation, Mosby Elsevier, St. Louis, sixth ed., page 257, 2009.
4. American Academy of Oral and Maxillofacial Radiology executive opinion statement on performing and interpreting diagnostic cone beam computed tomography. *Oral Surg Oral Med Oral Path Oral Radiol Endo* 106:561-2, 2008.
5. Turpin DL, Befriend your oral and maxillofacial radiologist. *Am J Orthod Dentofacial Orthop* page 697, 2007.
6. California Business and Professions Code, Section III.
7. California Business and Profession Code §1625.
8. Farman AG, Levato CM, et al, Education in the round: multidimension imaging in dentistry. *Inside Dent* pages 82-9, January 2008.
9. Friedland B, Medicolegal issues related to cone beam CT. *Semin Orthod* 15:(1)77-84, 2009.
10. American Dental Association: Principles of ethics and code of professional conduct, section 3, 2009. Principle: beneficence "do good."
11. California Judicial Council of California Jury Instruction (CACI) 508. Duty to refer to a specialist.
12. Nesari R, Rossman LE, Kratchman SI, Cone beam computed tomography in endodontics: are we there yet? *Compend Contin Educ Dent* 30(6):312-20, July-August 2009.
13. Goldman R, Brown JL, California Legal Handbook 1998, Section 17.4. When a general dentist attempts a specialty procedure instead of referring the patient to a specialist, he or she will be held to the specialist's standard of care.
14. California Code of Regulations, Sections 1016 and 1017.
15. Simone v. Sabo (1951) 37 Cal.2d 253, 257, 231 P.2d 19, 22.
16. American Association of Endodontists *Colleagues for Excellence* newsletter, 1997. Case Difficulty Assessment Form.
17. Wheeler S, Bollinger C, Complications or substandard care? Risks of inadequate implant training. *J Calif Dent Assoc* 37(9):647-51, September 2009.
18. Willard v. Hagemeister (1981) 121 Cal.App.3d 406, 412-3.
19. California Judicial Council of California Jury Instruction (CACI) 202. Direct and indirect evidence.
20. California Judicial Council of California Jury Instruction (CACI) 518. Res ipsa loquitur, June 2008.
21. California Judicial Council of California Jury Instruction (CACI) 505. Success not required.
22. Ludlow JB, Davies-Ludlow LE, White S, Patient risk related to common dental radiographic examination: the impact of 2007 international commission on radiological protection recommendations regarding dose calculation. *J Am Dent Assoc* 139(9):1237-43, 2008.
23. The 2007 recommendations of the international commission on radiological protection. ICRP publication. *Ann ICRP* 103;37(2-4):1-332, 2007.
24. U.S. Government Accountability Office (GAO). Medicare part B: Imaging services rapid spending and shift to physician offices indicate need for CMS to consider additional management practices, June 2008.
25. California Judicial Council of California Jury Instruction (CACI) 532. Informed consent — definition.
26. Tyndall DA, Brooks SL, Selection criteria for implant site imaging: a position paper of the American Academy of Oral and Maxillofacial Radiology. *Oral Med Oral Pathol Oral Radiol Endod* 89(5):630-7, May 2000.
27. Misch CE, Contemporary Implant Dentistry, Mosby Elsevier, St. Louis, third ed., 181,703-4, 2008.
28. Misch CE, Crawford EA, Predictable mandibular nerve location: a clinical zone of safety. *Int J Oral Implantol* 7:37-40, 1990.
29. Kraut RA, Chahal O, Management of patients with trigeminal nerve injuries after mandibular implant placement. *J Am Dent Assoc* 133(10):1351-4, 2002.
30. White S, Pharoah MJ, Oral Radiology Principles and Interpretation, Mosby Elsevier, St. Louis, sixth ed., page 600, 2009.
31. Silverman S, Demographics and occurrence of oral and pharyngeal cancers: the outcomes, the trends, the challenge. *J Am Dent Assoc* 124:115-6, 1993.
32. (no author listed) Weigh radiation risks vs. benefits of tests. J Calif Dent Assoc 37(8):516 August 2009. (Original source: Harvard Heart Letter, https://www.health.harvard.edu/newsletters/Harvard_Heart_Letter/2009/April/Radiation-in-medicine-A-double-edged-sword?utm_source=heart&utm_medium=pressrelease&utm_campaign=heart0409. Accessed Nov. 18, 2009.)
33. Mettles F, Magnitude of radiation used and doses in the U.S. National Council Radiation Protection and Measurements Scientific 6-2 analysis of Medical Exposure, 2006.
34. Einstein AJ, Henzlova MJ, Rajagopalan S, Estimating risk of cancer associated with radiation exposure from 64-slice computed tomography coronary angiography. *JAMA* 298:317-23, 2007.
35. Hall EJ, Brenner DJ, Cancer risks from diagnostic radiology. *BR J Radiol* 81(965):362-78, May 2008.
36. Amis ES, Butler PF, et al, American College of Radiology white paper on radiation dose in medicine. *J Am Coll Radiol* 4:272-84, 2007.
37. National Research Council. Health risks from exposure to low levels of ionizing radiation. BEIR VII Phase 2. Washington, D.C., National Academies Press, 2006.
38. Lee CI, Haims AH, et al, Diagnostic CT scans: assessment of patient, physician, and radiologist awareness of radiation dose and possible risks. *Radiology* 231:393-8, 2004.
39. National Council on Radiation Protection and Measurements. Ionizing radiation exposure of the population of the United States. Bethesda, Md., National Council on Radiation Protection and Measurements, NCRP Report No. 93, 1987.
40. Fazel R, Krumholz HM, et al, Exposure to low-dose ionizing radiation from medical imaging procedures. *New Eng J Med* 361(9);849-57, August 2009.
41. National Council on Radiation Protection and Measurements. Ionizing radiation exposure of the population of the United States: recommendations of the National Council on Radiation Protection and Measurements. Bethesda, Md., NCRP Report No. 160, March 2009.
42. White S, Pharoah MJ, Oral Radiology Principles and Interpretation, Mosby Elsevier, St. Louis, sixth ed., page 35, 2009.
43. California Judicial Council of California Jury Instruction (CACI) 534. Informed refusal — definition.
44. California Judicial Council of California Jury Instruction (CACI) 509. Abandonment of patient.

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Ocular Complications After Inferior Alveolar Nerve Block: A Case Report

TAHANI AL-SANDOOK, BDS, PHD, AND AYAD AL-SARAJ, PHD

ABSTRACT Ocular complications, transient loss of vision and diplopia, and blanching of the skin of the infraorbital region were reported in a female patient after an inferior alveolar nerve block for extraction of the permanent mandibular left third molar tooth. Injection of the anesthetic solution into the maxillary artery could result to such complications. The anatomy related to this case, with suggestions for management of such a patient is discussed.

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The inferior alveolar nerve block, commonly referred to as the mandibular nerve block, is the most frequently used and possibly the most important injection technique in dentistry. The most common complications of this block are: trismus, hematoma, and transient facial paralysis.[1]

Ocular complications are very rare but they can occur. Since 1960, 39 cases of ophthalmic complications have been reported in English literature. The main signs were transient loss of vision (amaurosis) and transient extraocular muscle palsy (diplopia). In all but three cases, the deficits were temporary.[2]

The most recent case of transient left lateral rectus nerve palsy and blanching of the upper lip was reported, following an inferior alveolar nerve block to enable the surgical removal of a permanent mandibular left third molar tooth.[3]

Transient loss of power of accommodation of the eye resulting in blurred vision was also noticed after routine inferior alveolar nerve blocks on the ipsilateral side. Clear vision returned within 10 to 15 minutes after completion of the block.[4]

The facial skin (blanching of the infraorbital region and upper lip), intraoral structures (blanching of hard palate) and eye (ptosis of upper eye lid) were affected after inferior alveolar nerve block, but within 60 minutes of the injection, all structures returned to their normal state.[5,6] Transient extraocular muscle palsy resulting from inferior alveolar nerve block was also noticed in children.[7]

This article documents the occurrence of ocular and cutaneous complications after an inferior alveolar nerve block. This paper also looks at the presenting factors, the anatomical considerations, and the management of the patient.

Case Description

A 28-year-old white female patient attended a private dental clinic for extraction of the permanent mandibular left third molar tooth. She was medically fit with a past dental history of apprehension and fainting after a local anesthetic injection, as well as manifesting a large broad mandible. An inferior alveolar injection was performed by using 2 percent lidocaine and epinephrine 1:100,000. Immediately after the injection, the patient felt dizziness, confusion, paleness, blanching, and numbness of the infraorbital region, diplopia, and blindness. After five minutes, the patient regained conscious but was still blanching in the infraorbital region. The patient was dismissed and booked for her next dental appointment. She left with a companion. On the next dental visit, the patient was fine, had no complaints, and the dental treatment was continued.

Discussion

A review of the literature revealed that most of the authors believed that the possible explanation for this phenomenon is the accidental injection of local anesthetic agents into the neurovascular bundle, which were carried via bloodstream to the orbital region but the exact mechanism is conflicted.[3-5]

One study mentioned that the injection of the local anesthetic into the inferior alveolar artery (branch from maxillary artery) traverses the middle meningeal artery (branch off the maxillary artery) and forms branches that anastomose with the ophthalmic and lacrimal arteries would account for diplopia.[5] This suggestion seems to unlikely because the inferior alveolar artery passes downward to enter the mandibular foramen and through it to mandibular canal for supplying the lower teeth.

Others suggested that the ocular complication would require the solution to spread from a site near the mandibular foramen in the infratemporal fossa where the inferior alveolar nerve is located.[8] Hence, the solution passes anteriorly to the pterygomaxillary fissure and the pterygopalatine fossa, and then through the inferior orbital fissure into the orbital cavity. Even within the orbit, the solution would have to pass through orbital fat and fascia and around densely packed structures to reach the nerves within the orbital cavity.

IMMEDIATELY AFTER the injection, the patient felt dizziness, confusion, paleness, blanching, and numbness of the infraorbital region, diplopia, and blindness.

If this explanation is accepted, this means that with the increased use of inferior alveolar nerve block, there is likely to be an increased incidence of ophthalmologic complications owing to its increased diffusion properties. Also expected is that the local anesthetic solution would have affected the other nerves in the region, such as the infraorbital and zygomatic branches of the maxillary nerve, as they travel through the inferior orbital fissure, or other motor branches supplying the extra-ocular musculature.[3]

Most probably, the local anesthetic solution could be injected into the maxillary artery and from it to the middle meningeal artery, which would enter the cranial cavity through the foramen spinosum. The terminal branches of the middle meningeal artery anastomosis with the branches of the opthalmic artery such as the lacrimal, ciliary, and even the central artery of retina.[9] Through this route, the anesthetic agent would reach the abducent, occulomoter, and optic nerves, as well as the ciliary ganglion. Therefore, the ocular signs appear as diplopia, ptosis, amaurosis, and loss of accommodation, respectively.

This possible precise anatomical explanation is supported by a study that mentioned the proximal portion of the maxillary artery crossed the posterior ramus of the mandible at a level that is closer to the level of the mandibular foramen. The same study showed a significant incidence of inferiorly looping of the maxillary artery immediately above the level of the mandibular foramen.[10]

Another study has shown that in a high percentage of cases, the maxillary artery passes laterally to the inferior alveolar and lingual nerves in the superior region of the infratemporal fossa adjacent to the mandibular ramus.[11] A large broad mandible may act as a predisposing factor for such complications.

The infraorbital artery is a branch of the terminal part of the maxillary artery that has passed from the infratemporal fossa to the pterygopalatine fossa, then emerges from the infraorbital foramen to supply the upper lip, lower eyelid, and the lateral aspect of the nose.[3,9] Injection of the local anesthetic into the maxillary artery allows the anesthetic agent to reach the skin of the infraorbital area through the infraorbital artery. As the epinephrine works peripherally on the adrenergic receptors of the skin and mucosa, the result is constriction of the blood vessels. This would account for the blanching of the skin localized to the infraorbital area, resulting from decreased blood flow.[5]

Conclusions

Ocular and cutaneous complications could occur when a local anesthetic solution is injected into the maxillary artery during inferior alveolar nerve block. Therefore, the dentist should always aspirate prior to depositing the local anesthetic solution. Treatment should be stopped when any ocular sign appears. The dentist also should reassure and explain to the patient that these effects are temporary. It is better for the patient to be escorted home and advised against driving and operating machinery until normal sight returns. It may be necessary for an ophthalmologist to follow-up with the patient.

Current studies show a more detailed knowledge of the branching of the various nerves and arteries of the head region. A thorough understanding of these neuroanatomical concepts and the potential variations in innervation are necessary for dentists to induce profound dental local anesthesia on a more consistent basis. ■■■■

REFERENCES

1. Malamed F, Handbook of local anesthesia, fifth ed., Elsevier Mosby, St. Louis, Mo., pages 228, 234, 2004.
2. Horowitz J, Almong Y, et al, Opthalmic complications of dental anesthesia: Three new cases. *J Neuroophthalmol* 25(2):95-100, June 2005.
3. Scott JK, Moxham BJ, Downie IP, Upper lip blanching and diplopia associated with local anesthesia of the inferior alveolar nerve. *Br Dent J* 202(1):32-3, Jan. 13, 2007.
4. Ngeow WC, Shim CK, Chai WL, Transient loss of power of accommodation in one eye following inferior alveolar nerve block: Report of two cases. *J Can Dent Assoc* 72(10):927-31, December 2006.
5. Webber B, Orlansky H, et al, Complications of an intra-arterial injection from an inferior alveolar nerve block. *J Am Dent Assoc* 132(12):1702-4, December 2001.
6. Uckan S, Cilasun U, Erkman O, Rare ocular and cutaneous complication of inferior alveolar nerve block. *J Oral Maxillofac Surg* 64(4):719-21, April 2206.
7. Spierer A, Spierer S, Transient extraocular muscle palsy resulting from inferior alveolar nerve block in children. *J Clin Pediatr Dent* 24(1):29-30, Fall 1999.
8. Penarrocha-Diago M, Sanchis-Bielsa JM, Ophthalmological complications after intraoral local anesthesia with articaine. *Oral Surg Oral Med Oral Pathol Radiol Endod* 90:21-4, 2000.
9. Snell RS, Clinical anatomy, seventh ed., Lippincott Williams & Wilkins, page: 831, 2004.
10. Lacouture C, Blanton PL, Hairston LE, The anatomy of the maxillary artery in the infratemporal fossa in relationship to oral injections. *Anat Rec* 205:104A, 1983.
11. Pretterklieber ML, Skopakoff C, Mayr R, The human maxillary artery reinvestigated, I: topographical relations in the infratemporal fossa. *Acta Anat* 142:281-7, 1991.

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- **DIXON:** *For Sale*-General Dentistry Practice. '08 collections were $122,894. 3 ops. 1,100 sq. ft. office. Owner has relocated out of state and is motivated. Good opportunity to build a practice in a growing community near Davis, CA. #14265
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- **MODESTO:** *For Sale*- General Dentistry Practice. 2008 Collections $1,097,000 adjusted net income of $350,543-No Medi-Cal. Office space is 3,580 sq ft, Laser, Intra & Extra-oral camera, and Pano. Office is open 5 days a week, 3 hygeine days. 2 or 3 dentist could work together comfortably in this facility. 10 years in same location. #14289
- **NO. CA WINE COUNTRY: ENDO PRACTICE** For Sale- 08' GR 958K adj net $673K 4 Ops, 1,500 sq ft. Overhead 29% Owner to retire #14296
- **PALM SPRINGS:** *For Immediate Sale* - General Dentistry Practice. 2008 Gross Receipts $906K with adj. net income of $346K. Highly desire able location with 4 ops. Laser, and Intra-oral camera. 5 days of hygiene. Owner recently deceased.
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- **REDDING:** *For Sale*-Owner looking for Assoc. trans. into Partnership w/Buy-Out. '08 GR $1 Million dollars income $436K. 5.5 days hygiene, 2,200 sq. ft. #14293
- **RENO: FOR IMMEDIATE SALE DECEASED DENTIST** - General Dentistry Practice. 2 ops, 17yrs. present location '07 GR $763K with adj. net of $263K w/65% overhead. Bldg. also for sale. Owner deceased.
- **ROSEVILLE:** *For Sale*-General Dentistry Practice. 2008 Receipts $834K with adjusted net income of $297,218. 64.4% overhead. Practice has been in this present location for the past 7 years. 15-18 New Patients a month. 6-treatment rooms in 2,100 sq ft. Laser, Intra-oral camera, and digital radiography.Owner relocating out of office.
- **SAN FRANCISCO:** Financial District 4 ops, 1,500 sq. ft. MERGER - Buyer needs to bring in Pt. base #14288
- **SAN FRANCISCO: Deceased Dentist.** General Dentistry Practice for Sale. Fee for Service GP Practice on busy street in lower Mission District. 2008 collections were $496,600. 4 ops. with Pano. 1,100 sq. ft. office. Practice in same location for 45 years. Hygiene 3 days a week. Refers out Endo, Perio, Ortho, Oral Surgery. Great opportunity for exp. Dentist. Owner Dentist is recently deceased. Temporary Dentist working practice until sale. #14299
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- **SOUTH LAKE TAHOE:** *For Sale*-General Dentistry Practice.Office is 647 sq ft w/ 3 ops. Practice has been in its present location for the past 26 years. Owner to retire. #14277
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MODESTO ***Price Reduction!***
Pending
Stunning 5 op GP located in freestanding single story building. State-of-the-art equipment. 2008 collections over $810,000.

CHINO - ***Price Reduction!***
4 op GP located in a dental complex. Stand alone building. 2008 collections $470,000+.

SOLANO COUNTY
Price Reduction!
4 op (3 equipped) GP with strong patient base. Efficient facility and proven systems. Collections $360,000+.

SAN FERNANDO VALLEY
SOLD
Spacious, 4 op family oriented GP located on main boulevard with easy access to 3 freeways. Gross $585,000+.

VENTURA COUNTY
Long established 3 op GP with a convenient strip mall location. Well trained staff. Collections are consistently growing with 2008 gross $424,000+.

BEVERLY HILLS - Patient Charts
Patient Charts of a long established GP. Seller is relocating.

LOS ANGELES (Endo)
4 op, long established endodontic practice. Located in an easily accessible professional building next to a major intersection. 2008 gross $500,000+.

NORTH COASTAL ORANGE COUNTY
5 op GP with an excellent location in a business complex. Over 30 years of goodwill. 2008 collections $298,000+.

MORENO VALLEY
Spacious, 2,700 sq ft, 7 op (6 equipped), GP with a busy location, 25 years goodwill, strong patient base & plenty of room for growth. 2008 collections $446,000+. Seller is relocating.

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FRESNO – (3) op G.P. (4) yr old eqt. Mixed patients. 2009 Projected Collect ~ $250K pt. **NEW**
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LOS ANGELES (KOREA TOWN) – 7 op computerized State of the Art G.P. with an Annual Gross Collection of $1.4M+ and an Annual Net Income of ~ $450K. Cash/Ins/PPO only. Cerec 3, digital x-rays, Dentrix s/w, ICAT Imaging System, (2) lasers, PRP System, & Full Lab. **NEW**
NORTH HOLLYWOOD – (4) op/(2) eqt'd Turnkey Dental Office w pts. Located in a grocery store anchored Shop Ctr. Excell exposure/visibility. Heavy foot traffic/walk ins. **PENDING**
PETALUMA – (2) op G.P. Cash/Ins/PPO/HMO. Cap Ck ~ $3K/mos. '09 Proj Gross $480K.
RESEDA – (4) op G.P. Cash/Ins/PPO/small amt Denti-Cal. Gross Collect $230K+/yr p.t. **NEW**
SAN JACINTO (HEMET AREA) – (4) op Computerized G.P. Absentee owned HMO pract. w $6K/mos Cap Checks. No Denti-Cal. 2009 Project. Gross Collect. $450K on a (3) day wk. **NEW**
SANTA CLARITA VALLEY – (11) op comput. G.P. (10) ops eqt'd 11th op plmb. Cap Cks. $14K-$16K/mos. Cash/Ins/PPO/HMO/min Denti-Cal. Annual Gross ~ $1.6M. **Back on Market**
STOCKTON – **WOW! ~ $18K/mos CAP Checks!** (7) op comp G.P. Cash/Ins/PPO/HMO pts. No Denti-Cal! Cap Ck ~ $18K/mos. '09 Projected Gross Collections ~ $1.25M. Absentee Owner.
TARZANA – (3) op G.P. in shop ctr. '08 Gross $551K+ on a 2-3 day wk. Mixed pts. **SOLD**
UPLAND – (3) op comput. G.P. in a strip ctr. Open 1½ yrs. Like new eqt. Digital. **SOLD**
VENTURA Multi-Specialty – 5 op comput paperless office, digital x-rays/Pano. Newer Eqt. 2 days/wk Pedo, 3 days/mos O.S., 2 days/wk Endo, 1 day/mos Perio. Gross $540K+ **REDUCED!**
WESTLAKE VILLAGE – TURNKEY OFFICE no patients. (4) op drop dead gorgeous office. Marble floors, travertine ctrs etc. (3) ops of newer eqt. 4th plumbed. Digital x-rays.
WOODLAND HILLS – (3) op comput. G..P. Dentrix s/w. Located in a strip ctr. Cash/Ins/PPO only. 2009 Proj. Gross Collect $700K. New eqt., digital x-rays/intra oral camera. **PENDING**

UPCOMING PRACTICES: Canoga Park, Covina, L.A., Montebello, Oxnard, & Simi Valley
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CLASSIFIEDS, CONTINUED FROM 62

OPPORTUNITIES AVAILABLE

OPPORTUNITY AVAILABLE — Dental Assisting Program Director wanted to develop curriculum/teach at new center in Tarzana, California. Experience required. Call Laura 818-758-3557.

OPPORTUNITY AVAILABLE — NORTHWESTERN WASHINGTON — Seeking experienced dentist for busy, established, rapidly growing, fee-for-service group dental practice. Excellent immediate income opportunity ($180,000 to $375,000 + 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, fax resume to Otto J. Hanssen at 425-484-2110.

OPPORTUNITIES WANTED

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

OPPORTUNITY WANTED — Board Certified Prosthodontist and Orofacial Pain (TMD/TMJ) Specialist looking for associate, buy-in, lease space opportunities in South Bay, Los Angeles County. Contact rfdruckman@gmail.com.

CONTINUES ON 70

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"Matching the Right Dentist to the Right Practice"

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

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3011 MID-PENINSULA GP

Located in a single story retail shopping centre. 2,000 sq. ft. office with 7 fully-equip. ops. Seller leaving area. 2008 GR 1.1M+ Asking $716K.

3013 SAN BENITO COUNTY GP

Now Available, quality well-est. practice with state-of-the-art equip. in attractive 2,246 sq. ft. fac. with 6 ops. Seller will be re-locating - out of area. Approx. 2,500 active pts. 2008 GR $870K+. Asking $563K.

3008 SOUTH ALAMEDA COUNTY GP

Quality oriented practice with a reputation for comprehensive, thorough care by well-trained and dedicated [illegible]ated in 2,100 sq. ft. [illegible] facility with 6 ops [illegible]M+, ~1,980 active pts. and [illegible] new pts./mo. Seller Asking $580K.

OFFER ACCEPTED

2999 NO. CA COAST

Flourishing Pediatric Dental Practice. Well est. with seasoned staff [illegible] pts., avg. 50-80 pe[illegible] over 2.2M in Gross [illegible] equip. 1,600 sq. ft. office with open bay and 2 quiet areas Asking $1,542,000.

OFFER ACCEPTED

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. GR for 2008 were $340K+. Annualized GR as of Oct 2009 are $335K+. Owner retiring and willing to help for a smooth transition. Asking 227K.

3015 NORTH BAY GP

Beautiful North Bay location, close to the Wine Country! Est GP offering 36 years of goodwill in a modern, fully-networked, 1,500 sq. ft. office. 4 fully-equip. ops with room for more. Approx. 1,300+ active pts. (all fee-for-service) with 10-15 new pts./mo. 2008 GR $886K on 4 Dr./week. Adj. net of over $300K. Asking $630K. Building also available to purchase. This is a wonderful opportunity.

2976 NORTH BAY SANTA ROSA GP

Beautiful, contemporary, state of the art office in a newly developed strip shopping center with anchor retailers. Averaging 40+ new pts/mo. with a 1,000+ active pts. (all fee-for-service). 4 ops (3 fully equipped) in 1,350 sq. ft. fac. Located on a well-traveled intersection with street signage and visibility. Owner willing to assist Buyer for a smooth transition. Asking $550K.

3010 MARTINEZ FACILITY & EQUIP

Live & practice near the marina. Incredible location and gorgeous 5 star facility. Turn-key, fully equipped, with all new equip. purchased in 2007. 6 ops in 2,740 square feet Seller will include approximately 400 active pts. at no cost. Asking 675K.

2986 SAN JOSE FACILITY & EQUIP

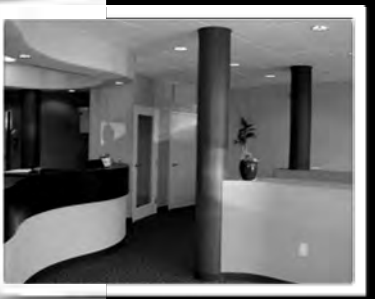
A 1 1/2 year-old stunning facility with small pt. base that has all the bells and whistles. 2,000 sq. ft., state-of-the-art dream office. Located in desirable comm./residential neighborhood close to O'Connor Hospital & Valley Fair Mall. 6 ops and new equip. For the est. GP who is looking to move into a larger facility or for the assoc. GP who is ready to start out on their own. Asking $475K.

3012 PENINSULA GP

Seller retiring from his long established general practice in [illegible] sq. ft. fac. with 3 fully equip [illegible]ated in desirable neighborhood close to down town area. 2008 GR $322K+ with a 4 day doctor work week. Asking $194K.

SOLD

Up Coming Practices:
Oakland & South Bay Area



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WESTERN PRACTICE SALES

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BAY AREA

A-6781 SAN FRANCISCO - Established in 1993. New equipment-hardly used. VIRTUALLY NEW practice! 1,000 sf/3 ops. **$65k**

A-7751 SAN FRANCISCO- ***Space Sharing.*** GP seeks DDS to share office in renowned 450 Sutter St bldg. ***Call for details!***

A-817 BELMONT- Surrounded by dental specialties in a 2-story Prof. Bldg w/easy access to public transportation. 860sf w/ 2 ops & plumbed for 1 add'l. **$210k**

A-829 SAN FRANCISCO Facility– Attractive Office w/traditional décor. 1600sf & 2 fully equipped ops. Priced at only **$49k**

B-755 BRENTWOOD FACILITY - Med. Prof. Bldg. Health care/comm. area. 1,500 sf/2 ops & plumbed for 1 add'l **$375k**

B-7881 TRI VALLEY, CA - ***Facility Only*** - Location, Location, Location! 1070 sf, 4ops, ADEC chairs and equipment. Fully networked Dentrix computers. **$400k**

B-8191 PLEASANT HILL/Facility Only– Located w/garden views in attractive, well-maintained, 2-story Dental/Medical Prof Bldg in heart of town. 1,248 sf & 4 unequipped ops **$595k**

C-690 SANTA ROSA -1050 sf with 3 ops. One of the most prestigious areas in Santa Rosa. Very mature landscape & beautiful office. Emphasis on Crown & Bridge, esthetics dentistry & prosthetics **$345k**

C-7361 SOLANO CO-FFS GP in thriving community! Spacious 2264 sf 6 op office near Yacht Club & Marina. **$375k**

C-787 SANTA ROSA - GP in very desirable area. 1700 sf , 4 fully equipped ops. Gross over $300k last year! Write your own success story here. **$150k**

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

C-809 VACAVILLE- Relaxed workweek! Stable patient base. Well-maintained, single-story Dental Prof. Bldg on major steet. Desirable Area. 1,500 sf / 4ops **$150k**

BAY AREA CONTINUED

D-779 SUNNYVALE - Well established GP in heart of Silicon Valley! 4 ops, 1050sf. Call for more information! **$225k**

C-820 VALLEJO- Strong, loyal patient base growing by word-of-mouth referrals. Located in popular & busy Shopping Plaza w/ excellent signage, visibility, freeway access & heavy foot traffic. 1,500 sf & 4 ops **$395k**

D-790 MORGAN HILL FACILITY - **SPECTACULAR!** Dental Prof Plaza on busy intersection. 1,730 sf/5ops, 3 of which are fully equipped. ***This is an Ideal Satellite Office for Specialty Practice!*** **$75k**

D-824 SANTA CLARA- GP - 35+ new pats/mo by word-of-mouth referrals. Retail Shp Ctr in heart of Silicon Valley. Just 6 years old w/ 1,500 sf & 3 fully equipped ops. Plumbed for 1 add'l op **$485k**

D-8301 SAN JOSE- FFS - "One Stop Shop" w/multiple Specialists under one roof. Exc Pt Base. Amazing opportunity in a highly desirable, family-oriented community. 2,400 sf & 8 fully equipped ops, **$1.2m**

NORTHERN CALIFORNIA

E-680 FOLSOM - Seller leaving behind all equipment & improvements! 2143 sf, 2 ops & plumbed for 4 add'l. Seller Will Consider ANY Reasonable Offer! **ONLY $150k**

E-748 SACRAMENTO -Convenient location. 820sf/2ops. Plumbed for 1 add'l. **$65k**

E-729 AUBURN - Busy retail shp ctr w/ excellent signage & good traffic flow. Well maintained FFS practice. 1750sf, 4ops. Plumbed for 2 add'l ops **$300k**

E-7121 SACRAMENTO AREA – Largely FFS. 1800sf, 4ops (+2 add'l plumbed). Highly visible, 2-story Prof bldg. **$775k**

NO. CALIFORNIA CONTINUED

E-782 ROSEVILLE-FACILITY- Spacious 1,850sf office. Open Bay w/4 chairs. Busy Pedodontic Practice in same building! **$50k**

E-808 SACRAMENTO-Quality Practice. Major Thoroughfare w/easy access. Free Standing Med. Prof. Bldg. 1000sf & 3 fully equipped ops **REDUCED $150k**

E-818 SACRAMENTO-Increase the part-time, relaxed workweek and watch the practice grow! Loyal Patient Base. Collections over $350k in 2007. 1,200sf & 4 ops. ***Building previously appraised @ $260k in 2004. $315k for Practice AND Real Estate***

E-821 *Facility* SACRAMENTO-Attractive office—traditional décor. Well-maintained, highly visible, single-story bldg. Great area. 1,400sf, 3ops. Plumbed for 1 add'l op **$60k**

F-7651 COASTAL EUREKA AREA-Near Thriving University. Vibrant student/staff population. Seller retiring. 2700sf, 6 ops. **$515k**

G-751 RED BLUFF/CHICO- Known for special sense of community & small town living. Complete remodel ~5 yrs ago. FFS GP. 2350sf / 4 ops equipped. Plumbed for 2 add'l. **Current Lender Willing to Carry Qualified Buyer. Practice Offered at $175k / Real Estate Also Available $250k**

G-761 CHICO-Seller retiring! 1000+ sf w/3 ops. Attractive Med Prof Bldg. Vibrant community **$150k**

H-634 WEST OF RENO—On the Feather River in Plumas Co. 1500 sf/ 4 ops, excellent location. Lease below market value. **$250k**

H-668 NORTHEASTERN CA– GP with over 30 yrs goodwill. 4 ops 1600sf office. 2007 gr rcpts exceed $650k **$395k**

H-831 SUTTER CREEK -**"Buy-in" opportunity during Seller's eventual retirement plans.** Dental Prof Bldg w/ ample parking on a busy scenic highway in desirable neighborhood. 4 ops. **$160k**

800.641.4179

WESTERNPRACTICESALES.COM

CENTRAL VALLEY

I-685 TURLOCK - 1700sf, 7 ops. Avgs 14 patients & 11 Hyg Pats/day! Practice recently remodeled. Highly attractive free standing building. Mostly Adec Eqpmt. **$350k**

I-772 *Facility* STOCKTON-Desirable, affluent health care area. 2,140sf/4 ops **$250k**

I-802 MODESTO - Facility. ~ 1500sf w/4 ops & room for 1 more. State of the art facility directly in front of Vintage Faire Mall **$445k**

I-823 MODESTO-Digital Ready Network . State of the Art GP. Superb Locale in busy desirable area. 2550 sf & 6 ops. **$400k**

***NEW!* I-840 TRACY-** Must See to Appreciate! Major thoroughfare / desirable area. 2,165 sf & 6 ops. Plumbed for 1 add'l op. $**445k**

J-733 TULARE/VISALIA-Desirable commercial area surrounded by schools, hospital & building complexes. 4 ops. **$400k**

J-801 FRESNO– Facility. ~ 1300sf and 4 ops. Traditional Décor. **ONLY $55k**

J-828 FRESNO - Attractive Corner Prof bldg w/ excellent visibility. 2,120 sf & 5 fully equipped ops **$585k**

SOUTHERN CALIFORNIA

K-735 ALISO VIEJO FACILITY - Upscale 2 story Prof Bldg. 1,800sf/4 ops. $4k sublet income at this location as well! **$225k**

K-741 SANTA MARIA- Spacious ops and picturesque windows capturing scenic views. . 1,200+ sf/3 ops + 1 add'l **$425k**

K-762 INDIAN WELLS– Well Respected practice w/loyal patient base. Newly remodeled, 1400+ sf, 5 ops **$550k**

K-793 SAN DIEGO-2500sf & 4 fully equipped ops w/ plumbing for an add'l 2 ops. Highly Desirable Neighborhood **$475k**

SOUTHERN CALIFORNIA CONT

K-805S SANTA MARIA - State-of-the-art, fully computerized, paperless office w/ digital x-rays. 1,450sf **REDUCED to $100k**

K-827 STUDIO CITY-Highly esteemed, 4 op fee-for-service practice setting the bar for excellence! Near Beverly Hills, W. Hlywood ,Westwood **REDUCED $515k**

K-805G GROVER BEACH- Draws tourists w/moderate coastal climate, drive-on beach, dune hiking, fishing, clamming, golfing, horseback riding, & wine tasting. Remodeled - 1,250sf w/4 ops **REDUCED to $120k**

K-816 MISSION VIEJO-Reputation as one of the best dentists in this vibrant OC Comm. Top-notch office in popular Rtl Shp Ctr. Close proximity to Gov. amenities & schools. 1,300 sf & 2 ops. **$325k**

NEVADA

LV-756 LAS VEGAS-Brand new 1,600sf/ 3 op office (Plumbed for 1 addl op) Attractive & well-equipped in Rtl Shpng Ctr. **$150k**

LV-796 HENDERSON - Master-planned community! Excellent location & easy freeway accessibility. Spacious, like-new office. 2,080 sf w/3 fully equipped ops & plumbed for 3 add'l ops **$295k**

LV-791 LAS VEGAS - Low Cancellations and High Collections! 12-20 pats/day. 1900sf with 4 fully equipped ops + plumbed for 1 add'l. **PRICE REDUCED!! $275k**

LV-565 LAS VEGAS - Nice Prof bldg. Multiple Lease spaces and size options in growing Rainbow/Sahara Area. Great Area w/ lots of potential. **PRICE REDUCED! NOW ONLY $325k**

LV-694 LAS VEGAS - Well established, large GP. 2200 sf & 6 ops. Gross Receipts over $900k. Equipment less than 5 years old. Office was recently painted and carpeted. **$545k**

R-810 DAYTON-Gross Rcpts over $1mil in 08! Amazing, quality, well-estab w/loyal, stable patient base & seasoned staff. Excellent signage, easy freeway accessibility, ample parking. 1,500sf & 5 fully equipped ops. **$595k**

NEVADA CONTINUED

LV-800 LAS VEGAS-Well Established FFS practice. Emphasis on prevention. Seasoned Staff. 3350 sf & 6 ops. **$785k**

R-841 RENO –Long-established, quality practice committed to patient education, technology & self improvement. Wonderful, stable patient base. Excellent signage, Centrally located in desirable, upscale neighborhood. 1,750 sf & 5 fully equipped ops. **$350k**

SPECIALTY PRACTICES

K-653 GARDEN GROVE—ORTHO - Desirable area. 2200 sf 4 chairs in open bay. 2 private ops. **$285k**

C-6821 SOLANO CO. PROSTHO- Personalized treatment in warm caring environment. 1040 sf with 3 fully equipped ops. **$390k**

E-742 ROSEVILLE ORTHO FACILITY 1,850sf w/ Open Bay & 4 chairs ***Strong referral base w/ busy Pediatric Practice in same building! NOW ONLY $50k**

I-7861 CTRL VLY ORTHO- 2,000sf, open bay w/8 chairs. Garden View. Antique Exam Room. 45 years of goodwill. FFS practice sees 60-70 patients daily. Prof Plaza. **$370k**

B-7851 EAST BAY ORTHO - LOCATION is Superb! 35-40 pats per day. Prof Dental Plaza. 1380 sf / 6 chairs **$450k**

C-7841 W CO.CO. COUNTY—ORTHO - Well established—35-40 patients per day. Busy Plaza Setting near local Middle and High Schools. ~ 1350 sf & 6 chairs in open bay. Just off I-80 corridor. **$400k**

E-811 SIERRA FOOTHILLS ORTHO- Fast growing area. Patient Oriented, Well respected Ortho practice. Avg 30 pats/day. 1200 sf & 3 chairs in open bay. **$175k**

Timothy G. Giroux, DDS

Jon B. Noble, MBA

Mona Chang, DDS

John M. Cahill, MBA

Edmond P. Cahill, JD

CLASSIFIEDS, CONTINUED FROM 66

RELOCATING? RETIRING? — Experienced practitioners seek to purchase practice in greater San Diego area. Please contact Roy at 518-281-1229 or Daniel at 310-892-0705.

PRACTICES FOR SALE

ARCHITECTURALLY OUTSTANDING — 2,600 sq. ft. dental office. State of the art equipment. Six operatories. Amazing opportunity brought upon by sudden change in owner's family situation. Fantastic demographics to grow the practice. For more information visit www.dentalofficeforlease.com or call Mark at 707-290-0636.

PRACTICE FOR SALE — MONTEREY BAY AREA — 20 year old general practice located in professional building. 4 well equipped operatories. 8 days of hygiene. Practice shows yearly growth in patient numbers and production. $920K in 2008. Send inquiries to: CDA, Attn: CDA Box 12010, 1201 K St., Sacramento, CA 95814.

PRACTICE FOR SALE – 40 year old, established general practice in Fresno. Good location in professional building. 4 equipped ops, panorex and intra-oral camera. 1,426 sq. ft. Priced right! Send inquiries to: California Dental Association, Attn: CDA Box 0809, 1201 K St., Sacramento, CA 95814.

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- 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.
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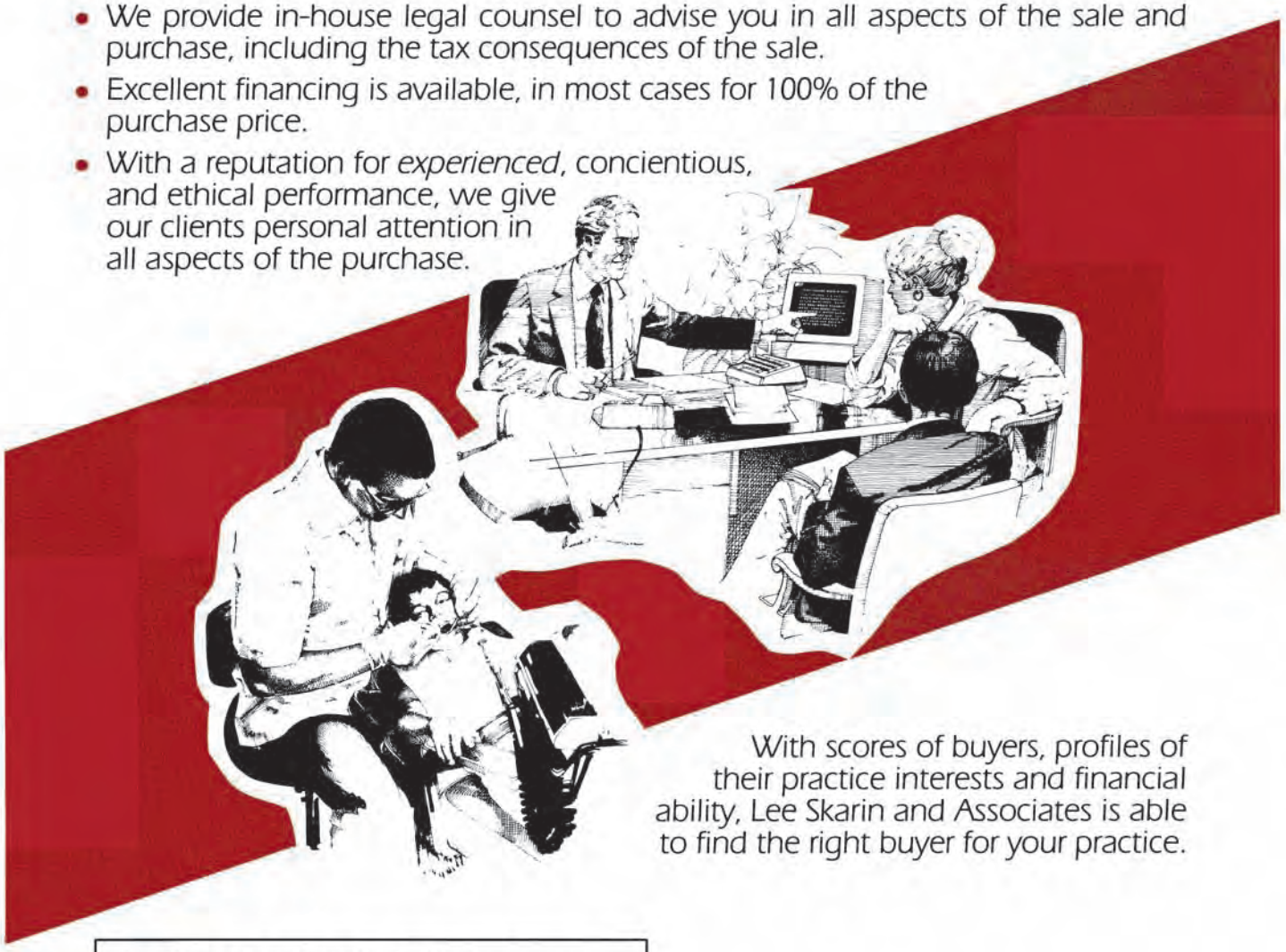

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ADVERTISER INDEX

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

DR. BOB, CONTINUED FROM 74

on page 3 of the *Hair, Nails & Extensions Gazette* that John and Yvonne's place featured a tank full of toothless finny pedicurists swirling around the little fake diver, chanting, "We want toes, we want toes, bring 'em on!"

Cautiously at first, the ladies of Alexandria (men are not into pretty feet so much) were quickly hooked in spite of the price hike to $50 for 30 minutes. Who knew? Herodotus had a clue because it was he, back in the middle 400s B.C., who first observed the Egyptian plover hard at work cleaning the teeth of torpid crocodiles along the banks of the Nile. Right on the spot, he coined the word "symbiosis" that, roughly translated, means "You clean my teeth and I'll refrain from eating you."

There are those — Cicero the Pooh-pooher, for one — who claim Herodotus had been hitting the Cairo equivalent of Plonk-in-a-Box a little heavy and there was no such thing as a "crocodile bird." Cicero called him "The Father of Lies," but never to his face since Cicero wasn't born until 106 B.C. This was why taunting his memory with "Liar, liar, your toga's on fire" was largely ineffective. Cicero made a habit out of irritating just about everybody until he finally popped off once too often and was executed Dec. 7, 43 B.C., a day that would go down in infamy. Still, Wikipedia has a full description of the avian hygienists online. Who are you going to believe?

The symbiosis between humans and animals seems to be evolving with gathering speed. Ant farms in third-grade classrooms thrive for upward of a week, bosom-nestling Chihuahuas are all the rage in Hollywood, and silver fox fur neck pieces will stage a comeback as soon as the foxes agree to stop squirming for an evening in exchange for a rodent treat. The foxes also ask PETA to refrain from christening them with red paint. They are getting union scale, but dry cleaning is not a covered benefit.

Right on the spot, he coined the word "symbiosis" that, roughly translated, means "You clean my teeth and I'll refrain from eating you."

It is not too big a leap of reason to see why dental hygiene may be next. The pluvianus aegyptia I've contacted seem to feel that, careerwise, a move to human dentition is a step up. Cranky crocs have made them aware of the fact there are better and safer ways of getting a meal available.

The ball is now in Tokyo's court. With spas expanding their services faster than a GMC dealer's unsold SUV inventory, it is only a matter of time before the Ooedo-Onsen Monogatari spa offers a complete foot and mouth menu. If the patrons will buy bird's nest soup, they will love a plover prophy. If so, those friendly folks back at John and Yvonne's salon in Virginia will have little trouble convincing the 5,000 people who have already gone the fish pedicure route to open wide in the sequel to Hitchcock's *The Birds*.

Perhaps the officials of the ADHA combining forces with the Audubon Society can come up with an answer to protect the profession, otherwise, as Honda said to Ford, "Tough noogies!" ■■■■

CHARLIE O. HAYWARD, 1945–2009

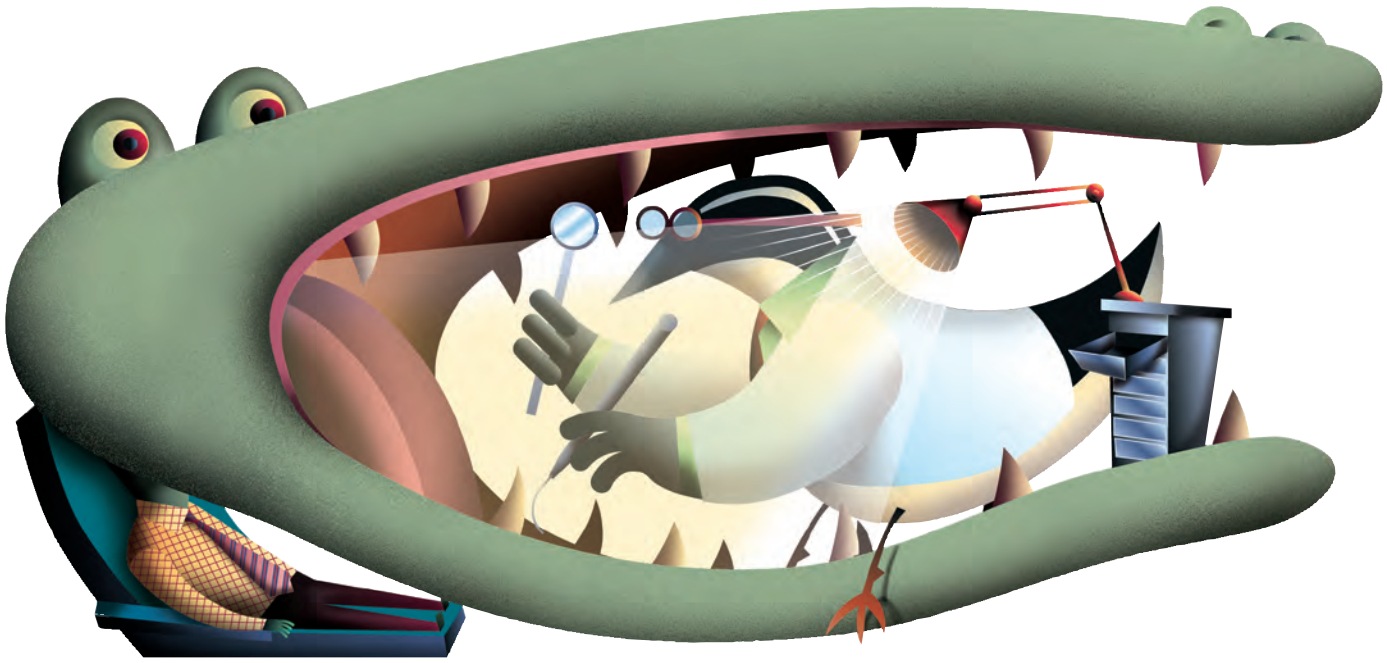
Nathan Root

Charlie O. Hayward graduated from the Art Center College of Design in Los Angeles. He created his own animated films and worked on projects for The Pink Panther, Sesame Street *and* Electric Company. *He combined his love of cars with his career by art directing* Car Craft, Rod & Custom *and* Hot Rod *magazines. For the last five years, he had been creating Tribal Totems of California Hot Rod Culture, sculptures made from hot rod parts. They can be viewed at flickr.com/photos/hot_art_studio.*

His first of many cover designs for the Journal of the California Dental Association *appeared in March 1989; the following month, he began illustrating Dr. Bob Horseman's column. Though they met face-to-face only twice, their collaboration produced an iconic feature, familiar to and beloved by thousands of members of the CDA family over two decades. It was with great sadness that we received the news of Charlie's passing. We send our gratitude for sharing their father with us and our deepest sympathy to his daughter, Carrie, and son, Casey. Donations may be sent to the Christian Science Monitor Operating Fund.*

CDA JOURNAL, VOL 38, Nº1

Doctor Fish



Fork over $8.75 (U.S.) and your tootsies will get the best pedicure ever, gush the tickled patrons.

Robert E. Horseman, DDS

ILLUSTRATION BY DAN HUBIG

I was going to tell you about the garra rufa this month then cleverly segue into a story about the Egyptian plover (pluvianus aegyptius), but I remembered none of this would make sense until I recounted the work of Herodotus, the father of history. You will recall Hysteria, the mother of History when she left in a huff with the two children of History, Fortunata and Ralph in 433 B.C. to return to the family home on the shore of the Aegean Sea. It was here at Halicarnassus she sought refuge with Grandmapola, the mother-in-law of History. Several years passed during which a lot more history happened.

Meanwhile in Ooeda-Onsen Monogatari, a hot springs spa outside Tokyo, sushi is getting its revenge. The owners have shrewdly imported from Turkey a school of garra rufa, popularly known in piscatorial circles as the doctor fish. These fish — and I'm sure if you check with Herodotus — are not a new idea, but it seems they have a thing for dead human flesh. Offer them a nice, live worm, or a tasty salmon egg and they laugh in your face. Ha, ha. They want your feet! In a pinch, your leg or hand will do but feet are the pièce de résistance to a doctor fish. Fork over $8.75 (U.S.) and your tootsies will get the best pedicure ever, gush the tickled patrons. They swarm over your toes and with delicate little nibbles, eat calluses, cuticles, and anything else that make feet the ugly things they are. Isn't that the grossest thing you ever heard?

Yes, but what about Herodotus, you ask? I'll get back to him when I tell you why dental hygienists are in big trouble. But first, let me introduce you to John Ho who runs the Yvonne Hair and Nails Salon with his wife Yvonne in Alexandria, Va. Not much that goes on in Tokyo gets past John, so it wasn't long after the fish pedicure thing appeared

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