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CDA JOURNAL, VOL 42, N°12

Zombie Dentistry?

Kerry K. Carney, DDS, CDE

Zombies are everywhere. Since George A. Romero's 1968 movie, *Night of the Living Dead*, zombies have staggered their way into most every corner of our cultural experience. But the other day, I was surprised to find they had made their way onto a dental-related Internet listserv. There was an intriguing conversation thread that grew out of a reference one of the listserv members had made to zombie dentistry.

We are familiar with zombies in music (Michael Jackson's *Thriller*), literature (Seth Grahame-Smith's *Pride and Prejudice and Zombies*) and video games (ADA's Stop Zombie Mouth campaign), but exactly what is zombie dentistry?

The definition of zombie dentistry appears to encompass practicing dentistry as a relentless exercise of counter-evidenced-based practices that survives and trudges on regardless of the data thrown at it.

It is natural to want to continue to do things just the way we have in the past. I have a friend who when given a study that contradicts his position, responds with, "I don't need to read that. I've read enough already." Sometimes, I agree with him. But doing the same thing over and over without a critical understanding is the basis of ritual. Our profession is based on science, not ritual.

There is an important difference between ritual and science. Science requires questioning and experimentation. To advance our professional skills, we must continue to explore and evaluate new evidence as it pertains to our ability to manage the oral health of our patients.

A while ago, I attended a C.E. course with a friend. The instructor asked how many years each of us had practiced. He then summed the numbers and told us we had 520 years of experience in the room. My friend whispered that we might have only one year of experience repeated 520 times. His point was: it takes more than doing the same thing over and over, year after year, to build experience. It takes exploring, trial, error and continual learning to increase one's experience.

Doing the same thing over and over without a critical understanding is the basis of ritual. Our profession is based on science, not ritual.

The recent composite of the American Association of Dental Boards[1] lists the continuing education unit requirements for license renewal by state. These vary considerably. (Though Colorado reported no required continuing education units for this list, on July 1, 2014, Colorado instituted a 30-unit requirement every two years.) Wyoming appears to require that the licensee be current in CPR only.

The continuing education requirement may be spread out over a range of years. The most common time period is two years (37 states including California and the District of Columbia). Seven states and Puerto Rico use three-year intervals, five states and the Virgin Islands require annual continuing education. South Dakota's is a five-year period.

When the unit requirements are divided by the time period, Kansas leads the way with its 30 units per year. In a five-way tie for second place, Arkansas, California, Delaware, Minnesota and Missouri all average out at 25 units per year.

The Dental Board of California established its current continuing education requirements to renew a license to practice dentistry on April 8, 2010.

All licensees must accumulate 50 units biennially. The requirement includes the following mandatory courses:

- Infection control (2 units)
- California Dental Practice Act (2 units)
- Basic life support, maximum of 4 units by the American Heart Association (AHA) or American Red Cross (ARC) course to include adult and pediatric CPR (including two rescuer scenarios), foreign-body airway obstruction, relief of choking (adults, child and infant), automated external defibrillation (AED) with CPR, and live, in-person skills practice session (skills test and written examination).

In addition to these mandatory classes, the licensee may accumulate up to 20 percent of the 50-unit requirement (10 units) in courses that do not involve the actual delivery of dental services to the patient or the community (for example, courses in organization and management of the dental practice). The remaining units must be accumulated from courses in the actual delivery of dental services to the patient or the community.[2]

Continual learning has been recognized as an important part of our profession for a long time. In 1969, "Minnesota became the first state to adopt mandatory continuing

education (C.E.) for licensure. Several other states, including California, followed suit in the next few years."[3]

In 1973, the very first House of Delegates of the newly unified California Dental Association passed a resolution requiring its members to earn 28 units of continuing education every two years to remain in good standing.

The state acted soon after that: "Effective with the 1974 license renewal period, if the board determines that the public health and safety would be served by requiring all holders of licenses under this chapter to continue their education after receiving a license, it may require, as a condition to the renewal thereof … courses of study satisfactory to the board."[4]

Of course, fulfilling C.E. unit requirements does not guarantee that the information imparted will be incorporated into the licensee's practice. (This is where zombie dentistry comes staggering into view.) One must critically evaluate the information received and actually change practice behavior when evidence indicates a better outcome is achievable.

This may not be as easy as it sounds. What if you have tried the "best practice" and you have had a poor outcome? Instead of critically examining the procedure and the outcome to see what went wrong and how that can be avoided in the future, sometimes it feels better to revert back to the tried-and-true, familiar practice. "I don't need to read that. I've read enough already."

Sometimes we feel betrayed by the science. "I did everything I was supposed to do and the outcome was bad." In a recent C.E. course, the lecturer presented a table of experimental results that indicated that the most reliable predictor of material failure was operator error. It never hurts to review the instructions.

Sometimes the evidence is conflicting. Under those circumstances it is incumbent upon us to critically evaluate the evidence, its source and the methodology that lead to the evidence. Sometimes we have to revert to the tried-and-true practice until further examination has proved one practice has a predictably better outcome than another.

It is not the number of years you have practiced that determines your expertise in the field. It is the way you have practiced.

There are so many opportunities to improve our knowledge, understanding and skills and hone our expertise in the field of oral health. Continuing education or life-long learning may be the most effective weapon mankind has in the battle against zombie dentistry. ■

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4. California Business and Professions Code Section 1645.

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Does the ADA Have a Code of Ethics?

by David W. Chambers, EdM, MBA, PhD

No. I read what we commonly think of this way every six months because it is a foundational document. However, what I read is the *American Dental Association Principles of Ethics and Code of Professional Conduct*, with advisory opinions. Three documents — none actually a code of ethics.

The Principles of Ethics contains very brief statements and definitions about autonomy, nonmaleficence, beneficence, justice and veracity. Pretty much everyone knows these now. They provide rational justification for a range of behaviors, often contradictory ones. Philosophers call such statements "thin claims" because they are academic and admit of multiple interpretations. Ethics should be a mutual understanding among all those affected — dentists, patients and the public — about what is in their common best interest.

The operational part of the ADA document is the Code of Professional Conduct. Here is where we find the patterns of behavior expected of dentists, such as truthfulness in representing one's qualifications, not splitting fees and the obligation to report gross or faulty treatment done by other dentists. It helps to remember that it was originally known as the Code of Etiquette.

Professionalism is an agreement among members of a professional group about how they expect other members of the group to behave. The code was created by and is amended by a vote of the House of Delegates. It covers behavior among dentists (the bulk of the ADA code) and behavior toward patients. No patients participated, as far as I have been able to determine, in the creation of the ADA code. Such documents are supposed to represent to the public what can be *expected of any* ADA dentist, and they serve as standards for what any ADA dentist can expect of his or her colleagues. The Principles of Ethics are aspirational; the Code of Professional Conduct involves provisions for sanctioning or removing ADA membership for those who are in violation.

The third part of the ADA code consists of advisory opinions. These apply to the Code of Conduct, not the Principles of Ethics, and only some of the items in the code have advisory opinions. The opinions are more detailed language, often examples, guiding the interpretation of the code. For example, in 4C (Justifiable Criticism), it is stated that when alerting patients of problems related to work done by a previous dentist this "should, if possible, involve consultation with the previous treating dentist(s), in accordance with applicable law, to determine under what circumstances and conditions the treatment was performed." Often the code is misunderstood as saying that one should refrain from commenting on what others have done because the circumstances are not known. The advisory opinion makes it clear that the dentist who sees problems should try to find out what is behind them. ■

The nub:

1. Know the ADA code inside and out – follow it.

2. Ethical principles are general justifications for what is done, but incomplete and sometimes inconsistent guides for choosing the right action.

3. One can practice in perfect harmony with one's peers and still be regarded by the public as missing the moral mark.

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

Study Offers New Recommendation on Free Sugars Intake

New research from University College London and the London School of Hygiene and Tropical Medicine has found that sugars in the diet should make up no more than 3 percent of total energy intake to reduce the significant financial and social burdens of tooth decay, according to a news release.

In the study, published in the journal *BMC Public Health*, the researchers analyzed the effect of sugars on dental caries and indicated there is a clear relation between sugars and caries. The authors used public health records from countries across the world to compare dental health and diet over time across large populations of adults and children. The authors found that the incidence of tooth decay was much higher in adults than children and increased dramatically with any sugar consumption above 0 percent of energy intake. Even in children, the authors noted an increase from near-zero sugar to 5 percent of energy doubles the prevalence of decay and continues to rise as sugar intake increases.

According to the new release, free sugars are defined by the World Health Organization Nutrition Guidance Advisory Group as those that include "monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit concentrates." Current guidelines from the WHO set a maximum of 10 percent of total energy intake from free sugars, with 5 percent as a 'target.' This equates to around 50 grams of free sugars per day as the maximum, with 25 grams as the target. The new study suggests that 5 percent should be the maximum, with a target of less than 3 percent.

For more information, see the study in the journal *BMC Public Health*, 2014, 14:863.

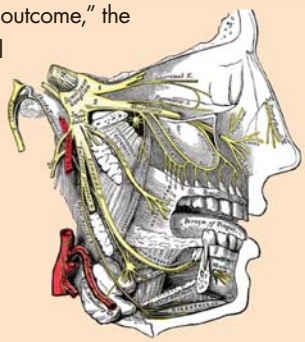
Study: When to Refer a Patient With a Nerve Injury

Because nerve injury is a known and accepted risk of many oral surgical and dental procedures, researchers of a recent study, published in the *Journal of the American Dental Association*, set out to determine when a patient with a nerve injury should be referred to a specialist.

Nerve injuries may occur despite the practitioner's providing the best of care, the authors wrote, noting that taking proactive measures during evaluation and surgery may reduce the incidence of nerve injury.

The authors report that "injuries to the peripheral branches of the trigeminal nerve can cause unfavorable effects on orofacial sensation and related functions such as eating, drinking, washing, speaking, shaving and kissing."

"When nerve injuries secondary to dental or oral surgery procedures fail to resolve promptly and the resulting dysesthesia is unacceptable to the patient, timely treatment gives the patient the best chance of a favorable outcome," the authors wrote in the study. "Treatment may involve surgical exploration and repair of the injured nerve."



The study reiterates that in order to give patients the best chance of achieving improvement or recovery of sensory function in the distribution of the injured nerve, recognition of and prompt referral to a specialist is crucial.

For more details, see the complete study in the *Journal of the American Dental Association*, August 2014, vol. 145, issue 8: 859-861.

Poor Oral Health in Elite Athletes

In a recently published consensus statement, researchers discussed how a high-carb diet, acidic sports drinks and a heightened risk of eating disorders are taking their toll on athletes' teeth, according to a press release from the *British Journal of Sports Medicine*. The statement noted that a poor understanding of the importance of good dental health on performance and training is also to blame.

In the statement, the authors draw on a comprehensive review of the published evidence and a recent symposium on the lessons of the London 2012 Olympic Games. Their review of the published evidence showed tooth decay affected 15-75 percent of athletes; moderate to severe gum disease up to 15 percent; enamel erosion 36-85 percent; and pericoronitis/impacted molars 5-39 percent.

"With clear psychosocial impacts of oral health, it would be surprising if training and performance were not affected in those athletes with poor oral health," the authors wrote.

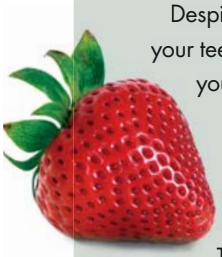
In an effort to explain the prevalence of poor dental health among athletes, the statement pointed to the preference for a high-carb diet and acidic sports drinks during training and performance, the impact of which is likely to be worsened by a dry mouth during competition, according to the press release.

There has been little research on elite athletes' attitudes toward dental health, but what exists suggests that their understanding of its importance is relatively poor, according to the authors, who noted that it does not appear to be a priority for trainers and sporting bodies either.

"Our purpose with this consensus statement is a call to action regarding oral health in sport since there is no evidence of an improving situation," the authors wrote.

For more information, read the full statement in the *British Journal of Sports Medicine*, published online first, Sept. 28, 2014.

Study: Strawberries Have No Effect on Teeth Whitening



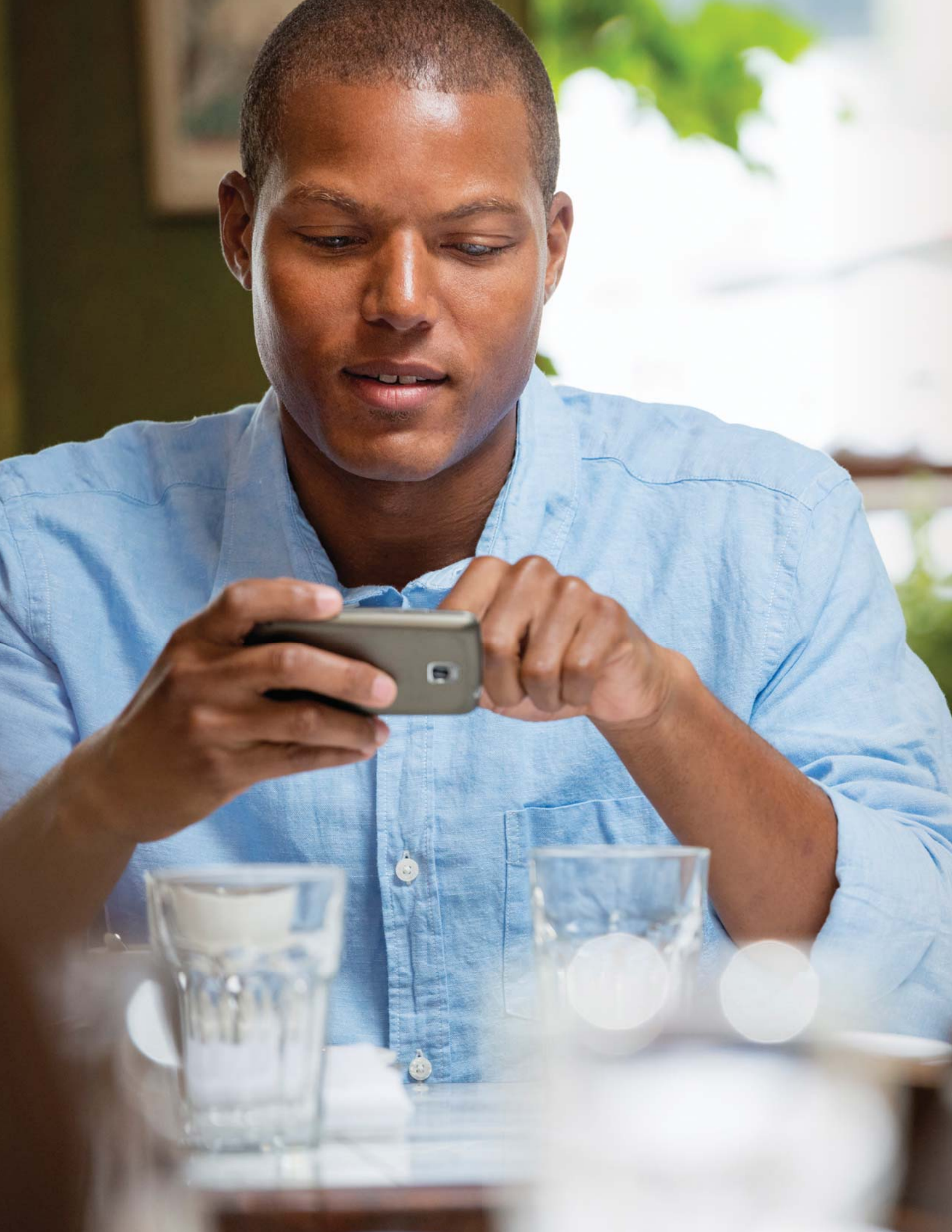
Despite claims by some media sources, recent research has shown that brushing your teeth with a do-it-yourself strawberry and baking soda mixture does not whiten your teeth, according to a news story from The University of Iowa.

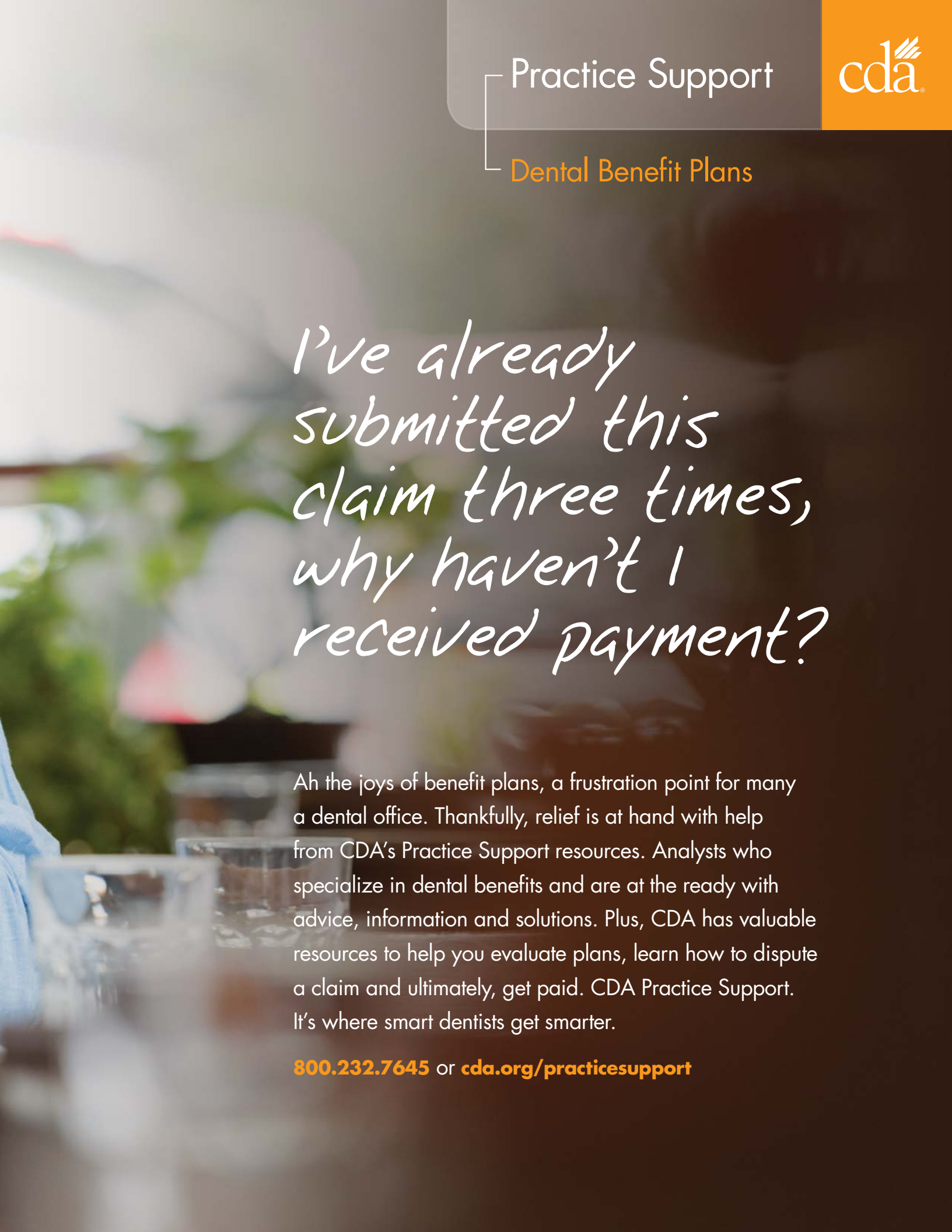
In a recent study, published online ahead of print in the journal *Operative Dentistry*, dental researcher So Ran Kwon compared a homemade strawberry-baking soda recipe to conventional tooth whitening modalities, including over-the-counter, dentist-dispensed for home use and in-office whitening products. The author used 120 extracted human molars that were randomly distributed to six groups and whitening was performed according to manufacturer's directions.

"DIY whitening was the least effective whitening modality," the author wrote. While the strawberry and baking soda formula did remove superficial debris, it produced no whitening effect. The other methods, Kwon found, not only remove debris but also provided a deeper, longer-lasting effect. Instrumental measurements were performed with a spectrophotometer and Kruskal-Wallis procedure was used to assess color changes among groups and intraclass correlation (ICC) to evaluate agreement between evaluators, the study noted.

"The only benefit of the do-it-yourself method (strawberries and baking soda) is while it seems to make your teeth look whiter, they look whiter because you're just removing plaque accumulation on your teeth," Kwon said in the story. "You really want something that penetrates into your teeth and breaks down the stain molecules. If you don't have that, you get just the superficial, and not the whitening from the inside, which was what you really want."

For more information, see the study in the journal *Operative Dentistry*, published online ahead of print, Oct. 3, 2014.





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Proper Oral Care May Lower Risk of Respiratory Infections in ICU Patients

New research has found that vulnerable patients in the intensive care unit (ICU) who received enhanced oral care from a dentist were at significantly less risk for developing a lower respiratory tract infection (LRTI), like ventilator-associated pneumonia, during their stay.

"Bacteria causing healthcare-associated infections often start in the oral cavity," said Fernando Bellissimo-Rodrigues, MD, lead author of the study, in a news release. "This study suggests that having a dentist provide weekly care as part the ICU team may improve outcomes for vulnerable patients in this setting."

The researchers analyzed data from 254 adult patients who stayed for at least 48 hours in a general ICU. Patients were randomized to receive enhanced dental care provided by a dentist, or to receive routine oral hygiene performed by the ICU nurse staff.

Enhanced dental care included teeth brushing, tongue scraping, removal of calculus, atraumatic restorative treatment of caries, tooth extraction and topical application of chlorhexidine corresponding to each patient's needs four to five times a week, according to the news release. Comparatively, regular treatment consisted of mechanical cleansing using gauze followed by topical application of chlorhexidine three times a day.

Patients who received enhanced dental care were 56 percent less likely to develop a respiratory tract infection during their ICU stay compared to the control patient group.

"Dental treatment was safe and effective in the prevention of LRTI among critically ill patients who were expected to stay at least 48 hours in the ICU," the authors concluded.

For more information, see the study published in the journal *Infection Control and Hospital Epidemiology*, vol. 35, no. 11, pp. 1342-1348.

Sleeping in Dentures Ups Risk of Pneumonia in Elderly

To identify modifiable oral health-related risk factors for pneumonia, authors of a new study prospectively investigated associations between a constellation of oral health behaviors and incidences of pneumonia in community-living elders 85 years of age or older. According to the study, among 453 denture wearers, 186 (40.8 percent) who wore their dentures during sleep were at higher risk for pneumonia than those who removed their dentures at night.

In addition, those who wore dentures during sleep were more likely to have tongue and denture plaque, gum inflammation, positive culture for *Candida albicans* and higher levels of circulating interleukin-6 as compared with their counterparts, the authors wrote.

At baseline, 524 randomly selected seniors (average age was 87.8 years old) were examined for oral health status and oral hygiene behaviors as well as medical assessment, including blood chemistry analysis, and followed up annually until first hospitalization for or death from pneumonia.

The study, published in the *Journal of Dental Research,* found that over a three-year follow-up period, 48 events associated with pneumonia were identified (20 deaths and 28 acute hospitalizations). Overnight denture wearing was associated with an approximately 2.3-fold higher risk of the incidence of pneumonia, authors wrote, concluded that their study "provided empirical evidence that denture wearing during sleep is associated not only with oral inflammatory and microbial burden but also with incident pneumonia, suggesting potential implications of oral hygiene programs for pneumonia prevention in the community."

For more, see the study in the *Journal of Dental Research,* published online before print Oct. 7, 2014.

Moderate Sedation Used Primarily for Dental Anxiety

For some patients, intense dental anxiety or fear can keep them from visiting a dentist. In a new study, dental researchers evaluated the sedation protocols used in three dental specialty programs at the Case Western Reserve University School of Dental Medicine.

"Moderate sedation is a useful adjunct in managing a variety of conditions that make it difficult or impossible for some people to undergo certain dental procedures," the authors wrote. For their study, researchers analyzed the dental school records of 84 patients who received care and moderate sedation during a visit to a Case Western Reserve's dental clinics in endodontics, periodontics and oral surgery graduate programs between 2010 and 2012.

Researchers found moderate sedation was primarily used to calm anxiety in more than half of the patients (54 percent), followed by fear of needles (15 percent), local anesthesia failures (15 percent) and severe gag reflex and claustrophobia from the rubber dam (both 8 percent).

Moderate sedation allows the patient to remain conscious by suppressing the brain's responses to pain and stress while still being able to communicate with the dentist. The three dental specialties reported using moderate sedation in conjunction with local anesthesia in order to control anxiety and pain, according to a news release from the university.

While moderate sedation helps to calm anxious patients, the catch is that not all endodontists are qualified to administer it. The procedure is not generally taught in most graduate endodontic programs, Montagnese said in the news release.

For more, see the study in the *Journal of Endodontics*, vol. 40, issue 9, pp. 1327–1331, September 2014.

Severe Periodontitis: Sixth Most Prevalent Health Condition in the World

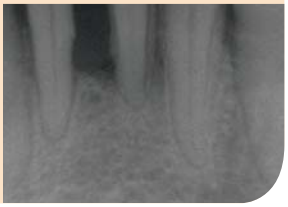
In a recent study from the International and American Associations for Dental Research (IADR/AADR), researchers have determined that in 2010, severe periodontitis (SP) was the sixth most prevalent health condition in the world, affecting 743 million people worldwide.

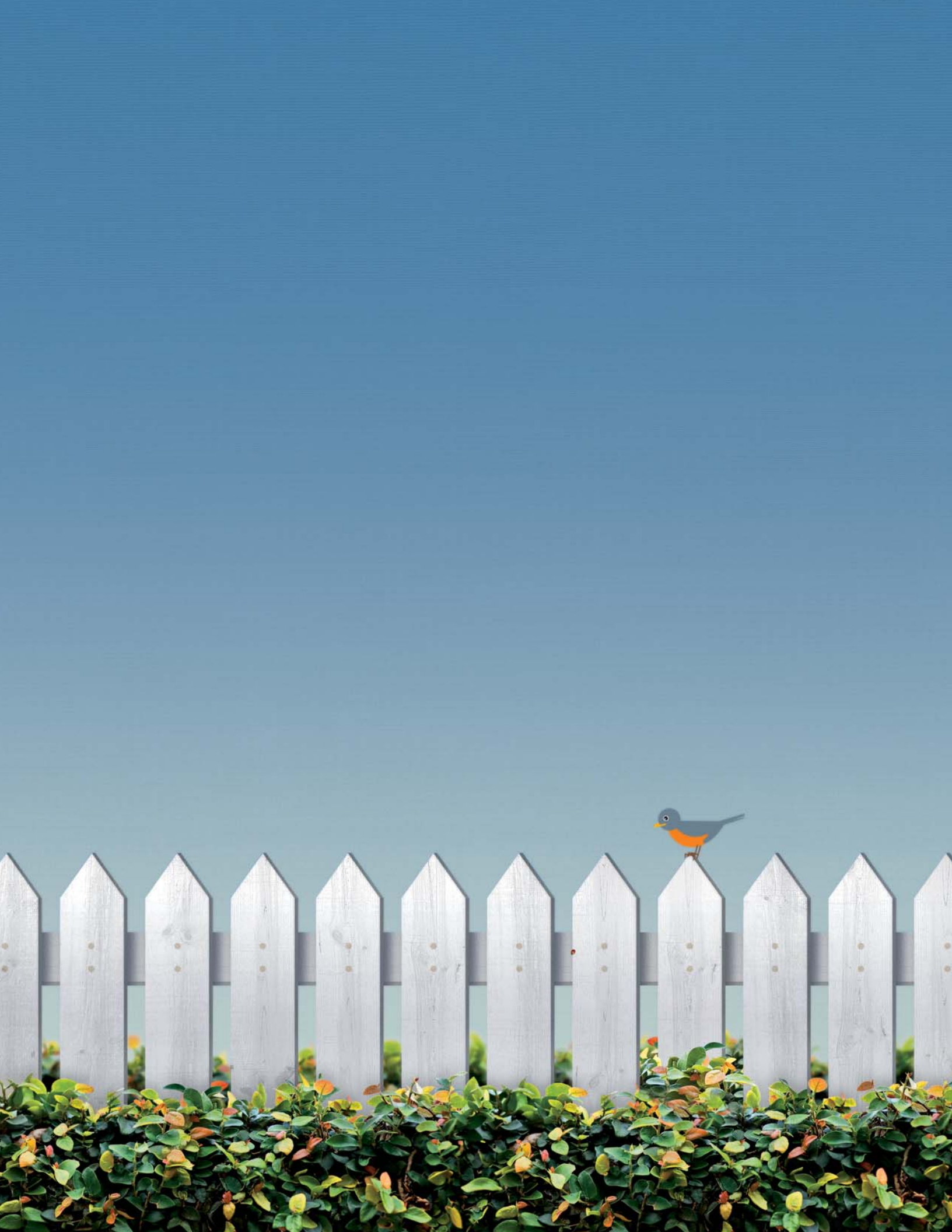
The purpose of this study, according to a new release, was to consolidate all epidemiological data about severe periodontitis and subsequently to generate internally consistent prevalence and incidence estimates for all countries, 20 age groups and both sexes for 1990 and 2010. From the systematic search, a total of 72 qualifying studies involving 291,170 individuals aged 15 years or older from 37 countries were included.

According to the authors, the study found the prevalence of periodontitis increased gradually with age showing a steep increase between the third and fourth decades of life that was driven by a peak in incidence at around 38 years of age. There were considerable variations in prevalence and incidence between regions and countries.

These findings underscore the enormous public health challenge posed by severe periodontitis and the authors concluded that policymakers "need to be aware of a predictable increasing burden of SP due to the growing world population associated with an increasing life expectancy and a significant decrease in the prevalence of total tooth loss throughout the world from 1990 to 2010."

For more information, see the full study in the *Journal of Dental Research*, November 2014, vol. 93, no. 11, pp. 1045-1053, or online ahead of print Sept. 26, 2014.





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Teeth in the Era of Implant Dentistry

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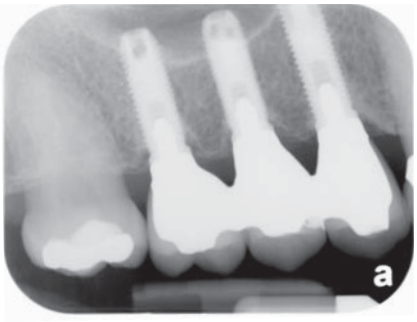
Implant dentistry is a great tool in rehabilitating fully or partially edentulous patients and one of the most significant breakthroughs in clinical dentistry.[2,3] Osseointegrated titanium implants were initially used in cases of completely edentulous patients because of the shortcomings of removable prosthesis despite the lack of double blind controlled studies to judge the efficacy of dental implants as a treatment modality,[4] providing advances relative to removable prosthesis with regard to function, esthetics and psychosomatic factors.[5,6] The effectiveness of dental implants in providing support for restorations in absence of teeth makes it the first choice for edentulous spans (**FIGURE 1**). However, implant dentistry has evolved from rehabilitation of lost dentition and masticatory function, to a contemporary tool in treatment planning for replacement of compromised teeth with questionable prognosis and replacement of healthy teeth based on "strategic extraction."[7] Decisions to replace treatable teeth with dental implants or for strategic extractions have garnered controversy, especially, in the presence of emerging evidence that implants are not immune to disease. There are many poorly understood biological and mechanical processes that contribute to peri-implant tissue response, including:

- Implants come in drastically different designs, surface characteristics and components that many times are market-driven and lack long-term scientific evidence.
- Patients present with variable risk factors for periodontal as well as peri-implant diseases.
- Operator expertise or the lack of it adds to the challenge.
- Studies that have reported long-term outcomes with one system or restorative design may not be applicable to other implant systems or even to other products from the same manufacturer.
- The understanding of biological response around any one implant system may not be applicable to another.

Contrasting the prognosis of teeth with that of implants is a clinical judgment that often seems to rule for the implant. Yet, how is this judgment being made when our understanding of implant prognosis is not as clear? This question is even more critical when one takes into consideration that our understanding of implant disease development and progression are not as clear as disease in teeth.

FIGURE 1A.



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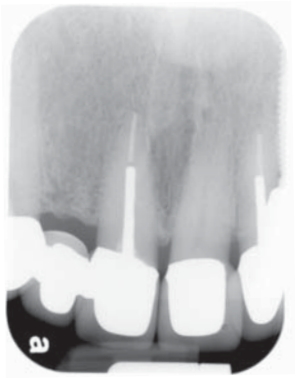

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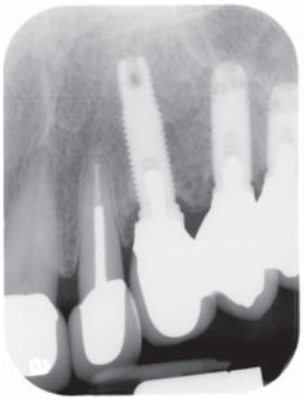

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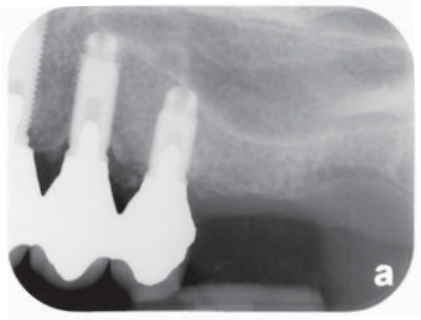

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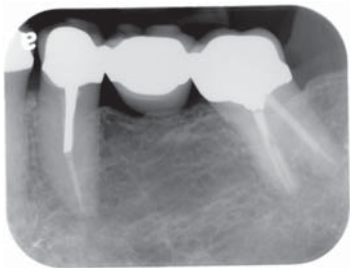

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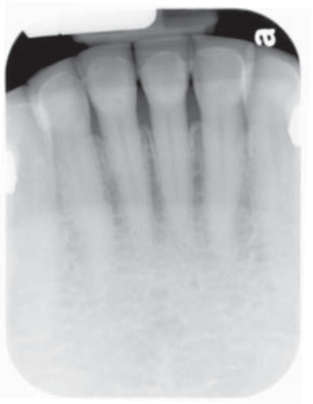


FIGURE 1G.

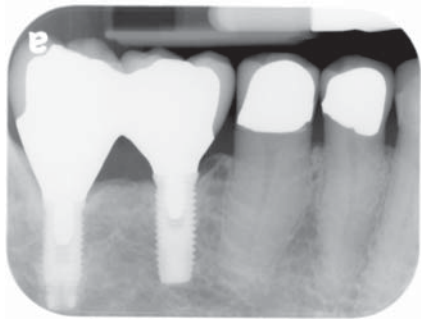


FIGURE 1H.

FIGURES 1A–H. Radiographic appearance of a 50-year-old patient with several missing teeth (**1A**) and a 10-year follow-up (**1B–H**). Note stable radiographic bone height around teeth and implants in presence of healthy periodontium and peri-implant tissue. (Restorative treatment courtesy of James Kim, DDS.)

The goal of this issue is to raise the following questions: Are we replacing lost teeth or are we replacing teeth with dental implants? Is it possible that the haste to replace teeth with implants is undue, and at times no better than the tooth that was replaced? What are the factors that can justify the decision to replace teeth with implants? Subsequently, some controversies and treatment planning factors that may sway treatment decision to maintain or replace diseased teeth are discussed.

Implants as Foreign Bodies

When comparing teeth to implants, the obvious contrast begins the moment we examine the interface of the anchorage apparatus of teeth versus implants, as well as their respective supracrestal soft tissue. Teeth are biological entities that erupt through a sequence of developmental process forming a biological dentogingival and dentoalveolar complex known as periodontium, whereas dental implants are foreign bodies inserted in to a developed jawbone. These foreign bodies are well tolerated, forming what has been described by Albrektsson as foreign body equilibrium leading to osseointegration[8,9] at the bone level and a scar tissue seal including epithelium and parallel oriented collagen fibers at the supracrestal level. Teeth and the dynamic biologic interface known as the periodontal ligament affect change on bone through forces, eruption, healing and disease. Implants, however, are static by design, circumstance and

chemistry, and have a zone of tolerance instead of ligament. This zone of tolerance is composed of a titanium oxide layer, which results in a combination of chemical forces and physiological reactions. This unique reaction within the bone to this particular substance is what has allowed for the emergence of implant dentistry and the departure from dependence on the periodontal ligament. Periodontal attachment (periodontal ligament and supracrestal connective tissue attachment) is the fundamental difference of the bone and soft tissue interface to teeth versus implants. This fundamental difference is the source of the different outcomes that we can achieve by implant treatment in contrast to teeth. Also, the lack of attachment around the implants underscores the challenge of soft tissue management and complications around dental implant prosthesis in contrast to teeth.

The difference in attachment apparatus around implants as compared to teeth is also the source of what is considered healthy and/or diseased around implants in contrast to teeth. The pathological changes around peri-implant tissues may be related to a disruption of balance between a well-tolerated foreign body and its surrounding biological as well as bacteriological components. The interface between bone and implant surface, which works so well in health, may not do so in disease, a possibility that must be considered when choosing implants over teeth. The topic of implants as foreign bodies is discussed in further detail by Frydman et al. in the first article of this issue.

Periodontal Prognosis Consideration in Implant Therapy

Prognosis of diseased teeth requiring several different therapeutic procedures, some of which have questionable outcomes, are continuously compared to dental implants. Often, the high success rates reported for implant-supported prosthesis are driving strategic extractions and replacement of teeth with dental implant prosthesis.[7] To provide a decision tree for maintenance versus replacement of diseased teeth, Avila presented a flow chart as a guideline considering several local tooth-related factors such endodontic factors, furcation involvement, remaining tooth structure, history of periodontal disease and periodontal bony defects.[10] In this context we must closely examine the synthesis of tooth prognosis itself. When the outcome measure is tooth loss, prognostic evaluation of teeth with periodontal disease poses a challenge. McGuire reported that teeth with a designation of hopeless prognosis show a substantial variability in outcome.[11] Patients with regular periodontal maintenance care exhibit better prognostic prediction than the ones with no maintenance care. The prognostic outcome of teeth will generally change for the better after periodontal infection and detrimental occlusal forces are addressed under a strict maintenance interval. Lindhe and Nyman have demonstrated that teeth with severe periodontitis and initial loss of attachment can be maintained long term when etiological and contributing factors can be controlled. Nonsurgical and surgical periodontal therapy and inflammation control with frequent periodontal maintenance is effective in maintaining teeth with a reduced yet healthy periodontium.[12,13,14] In a report by Kwok and Caton, it was suggested that factors that influence periodontal health and stability, such as systemic and local contributing factors, patient compliance, as well as occlusal and parafunctional forces, will affect prognostic assessment. Such prognostic assessment can help identify patients with greater susceptibility to periodontal breakdown that pose less predictability in the assessment of prognostic outcome.[15] In a study by Hirschfeld and Wasserman the prognostic predictability of questionable teeth was better for well-maintained (lower susceptibility) groups compared to patients in downhill and extreme downhill groups (higher susceptibility groups). Among the latter, even with an initially favorable prognosis, many of the teeth were lost.[16] In a study by Becker, predictability of poor prognosis teeth decreased from 80 percent among well maintained patients to 33 percent among patients without maintenance.[17] Moreover, utilizing a new evidence-based scoring system described by Miller et al.,[18] prognosis of molar teeth affected with moderate-to-severe periodontitis can be calculated with further accuracy. These long-term data of 15-40 years of observation suggests that furcation involvement may not be as much of a negative prognostic factor in tooth retention as it is currently perceived. Additionally, these data suggest that young patients with severe disease on molar teeth can have good prognosis with in-depth therapy.

Ultimately, the treatment decision is not dependent on periodontal prognosis alone. Functional and esthetic demands of patient treatment based on chief complaint, detailed cost benefits and risk benefits factors are the driving force of the treatment. What may be an acceptable risk for one patient and practitioner may not be acceptable for another. The influence of endodontic and restorative prognosis in maintenance or replacement of teeth is discussed in this issue by Simonian et al. and Moshaverinia et al. Furthermore, the differences in soft tissue considerations and therapy are discussed in an article by Caplanis et al.

Peri-implant Disease Versus Periodontal Disease

The relationship of periodontitis to the development of peri-implant disease as an etiologic factor is not well understood. Numerous studies have reported a history of severe periodontitis or aggressive periodontitis to be a risk factor for peri-implant diseases.[19-24] Still, a direct correlation between bone loss and attachment loss around teeth and implants in the same jaw is not demonstrated.[25] However, animal studies, cross-sectional and longitudinal human observations, as well as association studies, indicate that peri-implantitis is characterized by a microbiota comparable to that of periodontitis.[26] Periodontitis risk factors such as diabetes, smoking and poor oral hygiene seem to increase the risk for peri-implantitis. Some have argued the case for bacterial translocation from periodontitis to implant sites and suggested that by achieving periodontal health in the remaining dentition and utilizing relatively smooth abutments and implant surfaces, a reduction in bacterial translocation can be achieved.[26] With a three-year and five-year follow-up study, Mengel showed that oral rehabilitation with implants could be successful in partially edentulous patients treated for generalized aggressive and generalized chronic periodontitis. However, the success rate for implant therapy was 88.8 percent in the aggressive periodontitis group compared to 100 percent in the chronic periodontitis group,[27] suggesting that a relationship may exist between periodontitis and peri-implantitis.

Because patients with a history of periodontitis seem to be at a higher risk for peri-implant disease, one needs to consider the predictability of peri-implantitis treatment and compare it to that of periodontitis while deciding between retaining teeth or replacing them for dental implants.

Our understanding of peri-implant health and disease is vague. Most clinical factors often used in determination of health or disease status around teeth are lost around implants. Interpretation of the clinical significance of our most used clinical tool, a dental probe, is vague at best around implants, as they are subject to the implant placement, position of neighboring teeth and the restorative interface. Other clinical assessment tools, such as bleeding on probing, could be considered more objective, signifying inflammation, but it must be combined with radiographic bone loss, which must in turn be relative to particular positions along the implant.[28] Radiographic assessment of bone loss around the implant along with the pattern must also be discerned to distinguish between a "remodeling" or "pathological" process. The presence of pain or pus should also be incorporated to further distinguish between classifications.[29] For the clinician, this invariably leads to a subjective interpretation.

It should be taken into account that peri-implant bone loss, even in the presence of inflammation, cannot be regarded as de facto peri-implantitis.

The definition of peri-implantitis as a continuous loss of bone because of bacterially induced inflammation has been supported with animal models.[30-32,33] However, this has not been universally agreed upon or established in human studies. There is an existing hypothesis expressed by Albrektsson et al. that the cause of bone loss around implants could be a function of an imbalance in a foreign body equilibrium, also known as osseointergration, which can lead to a secondary bacterial recruitment leading to inflammation, therefore, questioning the process of inflammatory disease process around implants as peri-implantitis, a disease paralleling periodontitis.[8]

It should be taken into account that peri-implant bone loss, even in the presence of inflammation, cannot be regarded as de facto peri-implantitis. There are situations where peri-implant bone loss occurs initially because of factors unrelated to bacterially induced inflammation, such as loss of thin bone housing the implant, loss of grafted bone/bone substitute material around implants, extraction socket defects (such as cases of immediate placement), retained cement irritation and loose restorative components/abutments. Subsequently, a bacterially induced inflammatory process occurs independently or even concurrently that leads to clinical inflammation. These types of inflammatory events do not necessarily support peri-implantitis as a disease entity that parallels the process of periodontitis. Some consider bone loss of more than 1.8 mm with the presence of bleeding and suppuration as a sign of peri-implantitis.[23] Others regard any bone resorption after the first year as a sign of peri-implant disease.[34] There are authors who consider a total of 4.1 and 5.3 mm of bone loss to be within the normal range in the long term (14-20 years),[35] based on previously published criteria for successfully functioning oral implants.[36,29] With so many different interpretations and opinions, it is difficult to state what is and is not disease with implants. On the other hand, there are universally accepted classifications and definitions of disease and health around teeth.[37]

Based on a longitudinal study, Lindhe reported on a population where peri-implant mucosal inflammation occurred

in 80 percent of the subjects and 50 percent of the sites. Peri-implantitis was reported to be between 28 percent and 56 percent of subjects and 12-40 percent of the sites.[19] Risk factors such as poor oral hygiene, history of periodontitis, diabetes and smoking all increase susceptibility to adverse peri-implant tissue responses.[19] These risk factors are the same as those for periodontal disease.

In general, there are established criteria for assessment of periodontal disease that is far more stringent compared to criteria used for peri-implant tissue disease. For example, examining periodontal disease progression, Papapanou[38] reported a mean crestal bone loss of 0.3 mm per year over a 10-year follow-up study. In contrast, implant sites with a rate of 2 mm bone loss in the first year and up to 3 mm in three years post insertion, or in some instances 4-5 mm post insertion after 14-20 years, is considered "normal remodeling."[35] To contrast this view to stability of periodontium, a report by Lindhe and Nyman demonstrated stable levels of bone attachment even after full-mouth reconstructions on patients with very advanced periodontitis over a 20-year longitudinal period.[12,13] In periodontal literature, a rate of attachment loss of more than 2 mm in three years is considered a nonstable periodontal site.[39,40] Ironically, a rate of attachment loss considered uncontrolled periodontal disease seems to be regarded as "normal remodeling" of bone in the implant literature. To put this in perspective, based on the original length of the implant, this amount of bone loss can translate to a 30-50 percent loss of original bone level. When it comes to chronic periodontitis, generally it takes 30-40 years post eruption for teeth to experience a comparable loss of support. Yet, there is a tendency to assign those teeth a poor prognosis. Another consideration when comparing periodontal therapy success versus implant therapy success is the fact that the survival rate and success of periodontal therapy is measured after the detection of the disease, when damage to the periodontium has already happened. But the starting point of implant success is at the time of insertion, not at the time of peri-implant disease detection. This may not be a fair comparison since the tooth has already been present, functional and withstanding the periodontal disease process for many years prior to diesease detection. Therefore, to provide a fair comparison the survival and success of the teeth have to be assessed from the time of eruption when no damage to the periodontium was present to the time that the tooth was deemed questionable and/or nonmaintainable and symptomatic because of dental and periodontal diseases. Applying this criteria, teeth are by far more resilient and amenable to treatment when compared to implants (**FIGURE 2**).

One should ask, why are implants not held to the same standards as natural teeth?

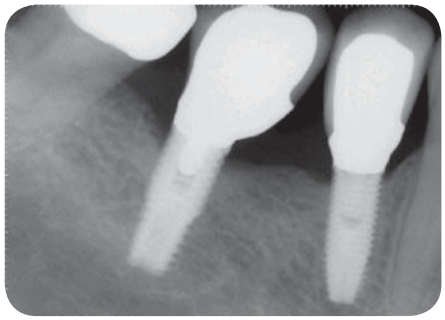


FIGURE 2A.

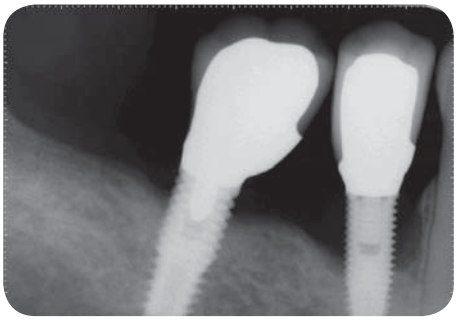


FIGURE 2B.

FIGURE 2C.

FIGURE 2D.

FIGURES 2A–D. Radiographic evaluation of mandibular right implant prosthesis (**2A**) at initial evaluation and (**2B**) after five years of loading. Note the advanced loss of bone around first premolar implant within a five-year time period after implant placement and no change of radiographic bone level distal of the mandibular right cuspid. Prognosis of any treatment around this implant is poor based on available evidence, and this implant may be considered for removal and replacement of implant in a more compromised bone volume. Radiographic evaluation of mandibular left cuspid of a 53-year-old patient (**2C**) at initial evaluation and five-year follow-up (**2D**). Note the advanced loss of bone affecting distal of the cuspid. Although advancement of the disease has occurred within the same period, based on the eruption pattern, it has been approximately 40 years before such periodontal defect is present. Several surgical and nonsurgical treatment options may be considered to maintain this tooth. (In collaboration with Maria Galvan, DDS, Ostrow School of Dentistry periodontology.)

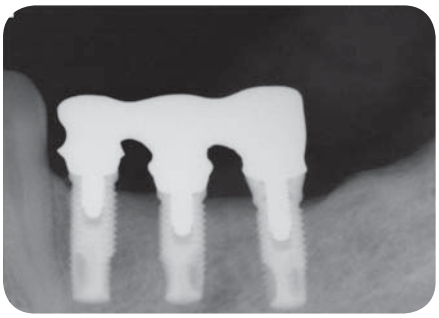
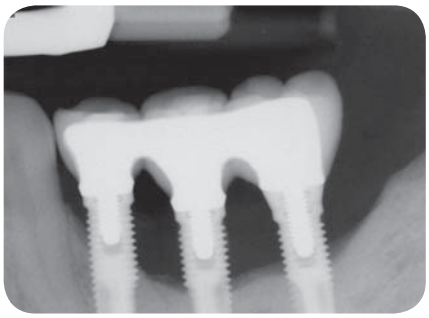


FIGURE 3A.



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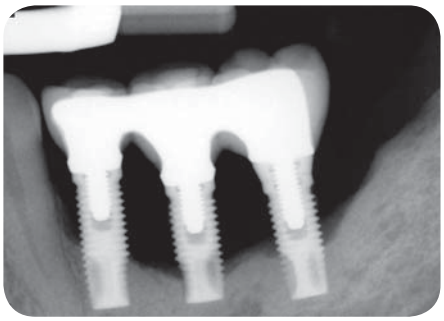

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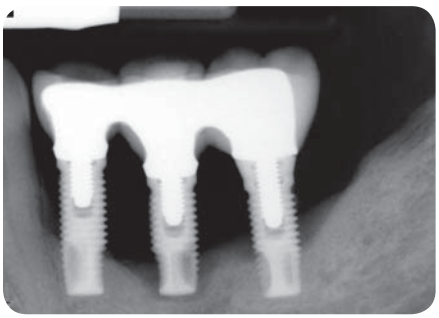

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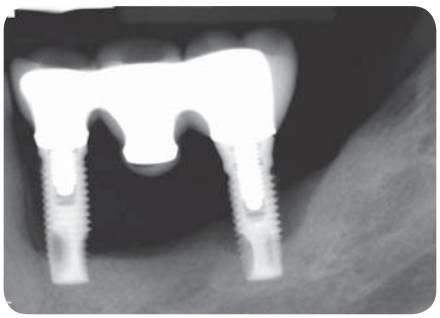

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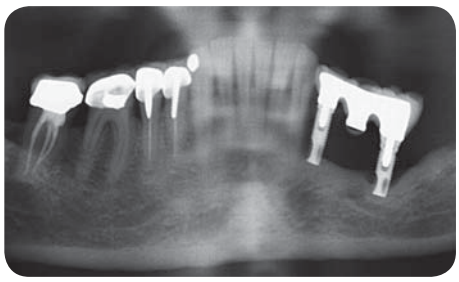

FIGURE 3F.

FIGURES 3A–F. Radiographic presentations of implant therapy for the mandibular left segment Nos. 19, 20 and 21 with subsequent progressive bone loss (peri-implantitis) on a 65-year-old patient (at time of placement). Five months after placement (**3A**), three years after placement (**3B**), four years after placement (**3C**), five years after placement (**3D**) and six years after placement and replacement of new prosthesis (**3E**). Continuous loss of bone in the absence of interventions has led to advanced bony defect and a severely compromised future implant site. Note the presence of the thin layer of the bone maintaining attachment at distal of tooth No. 22 despite advanced loss of bone on the adjacent implant. Seven years after implant prosthesis. Note the contrast of implant bone level to relative stable bone around remaining teeth with history of periodontal disease and endodontic therapy (**3F**). This an example of a contrast in long-term prognosis of teeth with more than 60 years in function as compared to implants seven years in function.

In the treatment of periodontal disease there is a point where the prognosis of the tooth and the cost to the surrounding bone prompts the decision for strategic extraction. This treatment option is entertained when predictable therapeutic outcomes are nonexistent and often when a dental implant is favored. However, more dental implants are now presenting with progressing disease, bone and even implant loss with limited predictable therapies to address them. Treatment modalities of resective or regenerative therapies for peri-implantitis have little long-term success, varied results and often involve esthetic compromise.[41,42] In light of the available data, in cases of peri-implant disease with more than 50 percent bone loss, the best strategy may be to remove the implant to prevent any further bone loss that can compromise future reconstruction of the site[43] (**FIGURE 3**).

The questions that beg to be addressed are: Why is it acceptable to have bone loss around implants at rates that are not afforded to teeth? If implants are the solution, how serious was the problem?

Conclusion

Implant dentistry provides great treatment options in rehabilitation of function and improves quality of life when there are missing teeth. A decision to remove damaged teeth or a strategic extraction of undamaged teeth to rehabilitate with implant supported prosthesis poses a great treatment planning challenge for clinicians and patients. There still are many gaps in our current understanding of implant dentistry to confidently make a choice to replace teeth with dental implants. Implants come with wide variety of designs and surfaces. The available long-term data about one implant system or prosthetic design cannot be extended to other implant systems or prosthetic designs because of biomechanical and biological variabilities amongst different systems and designs. Operator expertise in execution of surgical and restorative phases of implant therapy also adds to the challenge. The criteria for prognostic evaluation and health of teeth and implants are not the same. Several known and unknown risk factors influence prognosis of teeth and implants. Some are patient related and some are device related. Teeth are biological entities that are completely different from implants that can be considered well-tolerated foreign bodies. Therefore, the biological responses around the two entities are not the same, making comparisons between them unrealistic. The decision-making process to replace the teeth based on prognostic prediction

of the two entities is complex and should be individualized for patients.

The aim of this issue is to highlight the notion that, based on scientific evidence, dental implants are great alternatives when there are no teeth. However the question remains if they are a good alternative to replace teeth from a prognostic standpoint. Because this question may not be fully answered based on current evidence, the decision to replace existing teeth with dental implants should be weighed with extreme caution based on chief complaints, risk/benefits and cost/benefits factors. It is critical to define the overall goals of treatment through a comprehensive plan and an objective communication among health care professionals and the patient to underscore the challenges in predicting a therapeutic outcome with the goal to orchestrate realistic patient and operator expectations. ■

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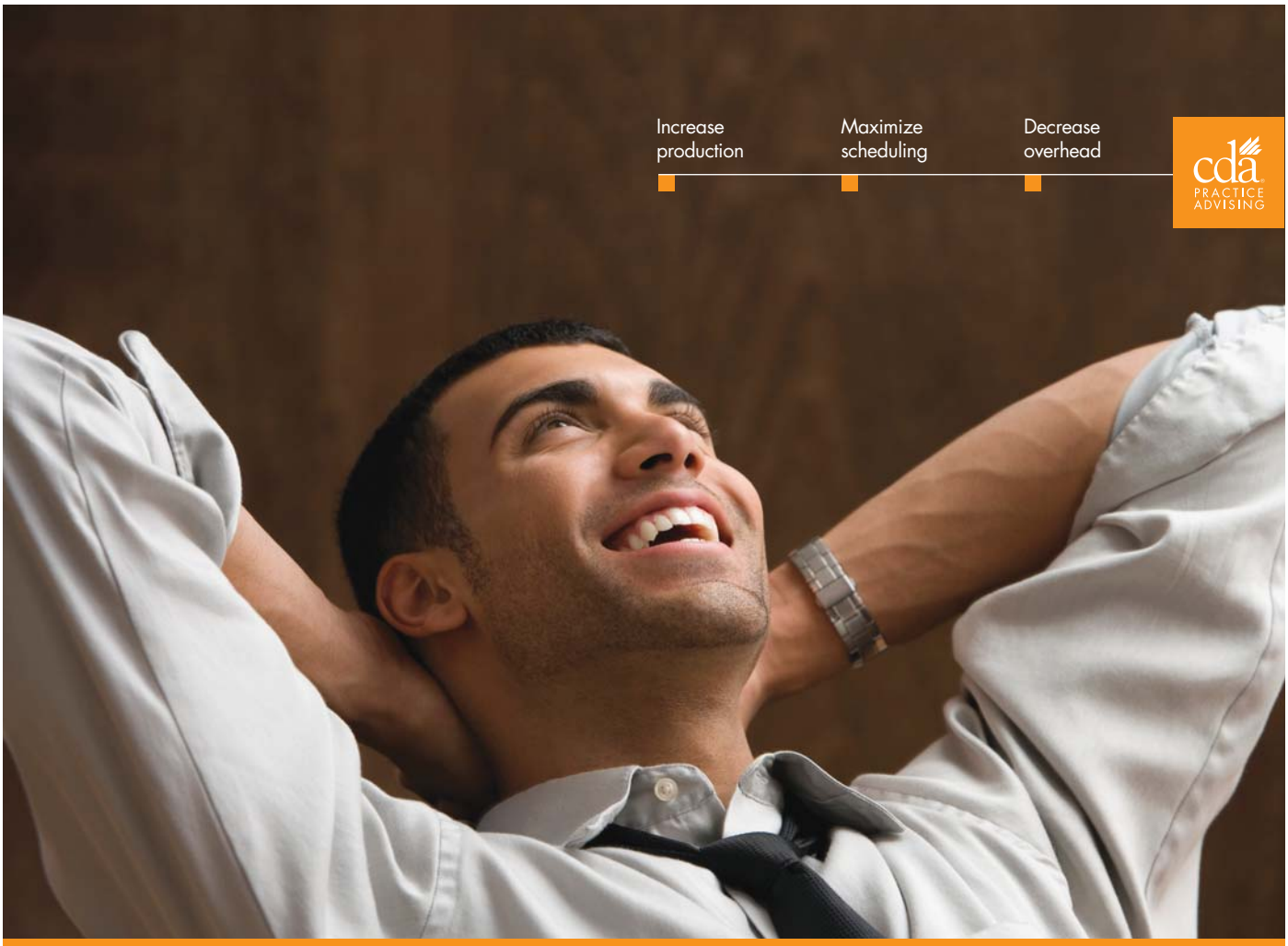

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Review of Models for Titanium as a Foreign Body

Alon Frydman, DDS, and Krikor Simonian, DDS

ABSTRACT A growing number of theories has evolved attempting to explain the process of dental implant failure. Titanium implants utilized outside of the mouth have exhibited breakdown through a foreign body reaction. Phenomena occurring in the body, such as passive dissolution, osteolysis and metallosis, have not been discussed relative to dental implants. The dental community must consider the full spectrum of implant interactions within the body to understand the differences and similarities within the mouth.

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As we observe more dental implant failures, a growing number of theories has attempted to explain the process, etiology and potential therapy to address it. With the emergence of these theories, there are intuitive biases that affect our direction and focus. With a good understanding of the pathogenesis and progression of periodontal disease, many theories regarding implant failure are following parallel constructs. Most researchers have focused on peri-implant breakdown as a disease involving host response to a microbial insult, namely peri-implantitis. However, other authors are looking in entirely different directions and see implants as foreign bodies and their breakdown as a foreign body reaction. To this day, neither theory has an exact mechanism to explain this breakdown, yet the peri-implantitis model is more accepted. The models offered for both theories are based mostly on speculation and assumption. When examining titanium implants utilized outside of the mouth, there is evidence to support breakdown as a foreign body reaction. Phenomena occurring in titanium implants in the body such as passive dissolution, osteolysis and metallosis have not been discussed relative to dental implants. Emerging science within the dental community may serve as a bridge between possible parallels seen in medical and dental implant failure. Until the understanding of dental implant breakdown is fully understood, the dental community must consider the full spectrum of implant interactions within the body to understand the differences and similarities within the mouth (**FIGURES 1** and **2**).

FIGURE 1A.

FIGURE 1B.

FIGURE 1C.

FIGURES 1A–C. Peri-implant bone loss and failure within one year.

FIGURE 2. Note the bone immediately in contact with tooth No. 9.

Osseointegration

Historically, attempts to implant foreign elements into jawbone have met with competing ideas and fashions, which have often influenced what material and approach were used. Principles developed early on were borrowed from other dental disciplines, such as removable prosthodontics, and looked for support, stability and retention, all the while using the bone as a saddle instead of housing. Multiple substances were explored before using titanium with bone for retention.[1] Noble metals offered minimal risk of oxidation reduction. While this made them safer, it led to less integration, more incidences of encapsulation and minimal removal torque relative to integrated implants.[2] Reactive metals had the opposite issue. As they are prone to oxidation-reduction, they have less fibrous encapsulation but more surface breakdown and leaching into the body.[3]

Unlike teeth that have a periodontal ligament, titanium implants are static by design, circumstance and chemistry and have a zone of tolerance instead of ligament. This zone of tolerance is composed of a titanium oxide layer, which results in a combination of chemical forces and physiologic reactions.[4] The resulting phenomenon, termed osseointegration[5] is a microscopic region of approximately 20-50 nm where the implant surface will never contact bone directly.[6,7] This space within the titanium oxide buffer results in a cloud of zwitterionic forces, which is strong enough to create a moment of friction that prevents any movement.[8] The physiology of bone recognizes this oxide buffer and grows intimately close, extending toward the buffer zone with layers of lamellar bone and ground substance.[1] This unique reaction within the bone to this particular substance is what has allowed for the emergence of implant dentistry and the departure from dependence on the periodontal ligament.

Despite this seemed solution, implants do sometimes fail. The science of implant dentistry is now searching for the reasons of loss of osseointegration and the mechanisms of implant failure. Articles from some of the early pioneers in implant dentistry are arguing for a departure from the influence of periodontitis on the way we consider peri-implant disease, offering osseoseparation as a correct nomenclature.[9] Because an exact mechanism for any of the theorized modes of breakdown is absent, we should instead look outside the mouth to gain insight.

Nonspecific Immune Response to Titanium

Utilization of titanium ball-and-socket joints has been studied extensively since its inception. One of the major complications from early designs was seen through the phenomenon of metallosis. Metal-on-metal wear results in the creation of titanium particles that extend into the body.[10,11] The phenomenon of metallosis initiates two predominant types of tissue reactions: a nonspecific macrophage-mediated granulomatous response and a lymphocytic-dominated response which has immunologic memory and is mediated by T cells.[12] The metallosis model lends support to a foreign body reaction to titanium dental implants as it offers a possible route for activation of the immune system in an aseptic environment, removing the need for a microbially driven immune reaction. With joint replacement implants, the nonspecific macrophage-mediated bone breakdown is triggered by both titanium particles as well as serum ions being released at the femoral head.[13] As macrophages phagocytize small titanium particles resulting from wear within the joint, they subsequently signal osteoclastic activation, differentiation, formation as well as prolonged activity and overall bone resorption.[14,15] In addition to affecting bone resorption, these same titanium particles have been shown to suppress osteoblast function, shifting the balance of normal bone remodeling.[16] Many studies note the ability of titanium particles ranging from 1 to 3 microns to stimulate

macrophage activity yet it is still not clear if there is an issue with the size of the particles or the number of particles as the trigger for bone degradation.[17-19] Some tests have shown that titanium particle size of 1 micron resulted in macrophage stimulation, increased bone resorption and increased IL-1 secretion.[20] A possible confounding variable seen in hip joint replacement is the presence of polystyrene within the tissue as well, something that would be absent in dental implants.[21] These same-sized particles have also been shown to negatively affect fibroblasts, increase matrix metalloproteinases (MMPs) and increase collagenase, as well as suppress collagen and osteoblast synthesis.[22] This can be an argument for the shifting of balance within the bone between natural osteoblastic and osteoclastic function and the resulting peri-implant bone loss. In comparison, dental implants have exhibited metal-on-metal wear at the implant abutment interface, creating a multitude of titanium particles.[23] Continuous loading of the abutment implant interface has been shown to yield titanium particles ranging from nanoparticle to micron sizes in dental implants.[24] Studies in mini pigs have shown the presence of titanium particles 5-30 microns within the bone immediately adjacent to dental implants in the mandible and subsequently within distant organs.[25] This was presumed to be the result of forces upon the implant body during placement. There also exists a possibility of fatigue and elastic deformation within the implant body resulting in fragments and particles of titanium breaking off during the life of the implant.[26] In ceramic-coated implants there exists another opportunity for breakage of particles that may contain portions of the implant body.[27] It is evident that dental implants have similar capabilities of producing titanium fragments in sizes similar to those in joint replacement. Altogether it may be possible that dental implant failure may follow some of the same routes as those in joint replacement through activation of the nonspecific immune response.

Titanium Oxide Breakdown

The titanium oxide buffer is generally believed to protect the implant body from corrosion. However, the implant abutment interface may allow for the phenomenon of fretting corrosion and subsequent titanium particle release from the implant. Typically seen with titanium-to-titanium wear, fretting reduces the corrosion resistance of the implant body by destroying the titanium oxide layer and reducing the possibility of repassivation of that layer.[28] This break in the armor can serve as a nidus for a full spectrum of immune reactions even in the absence of bacterial challenge. Galvanic reactions have also been offered as challenges to the titanium oxide buffer. When restorations utilizing nonprecious metals make contact with the titanium, a galvanic reaction occurs affecting the integrity of the titanium oxide layer ultimately allowing for corrosion.[29] Recent examination of mRNA signatures in periodontitis, peri-implantitis and healthy individuals supported a much higher innate immune response in the peri-implantitis group than the periodontitis group, which exhibited more of a bacterial response profile. This may support the foreign body model and not the peri-implantitis model as the titanium surface itself may have breaks in the buffer allowing for an immune response.[30] Another process offered for the break in the titanium oxide buffer occurs with the phenomenon of passive dissolution. Passive dissolution is defined as deterioration of passive titanium surfaces without any wear upon those surfaces. This phenomenon can occur in scenarios where titanium is not completely in bone but in contact with soft tissue,[31] such as a dental implant. Experimentation with rats showed elevated levels of titanium in those who had a nonloaded titanium wire placed in the femur versus those without.[32] Commonly in implant dentistry there is a transgingival component where either the dental implant collar or the implant body traverses the tissue outside of bone. This is a possible location where passive dissolution may occur. Similar and perhaps the closest to dental implants is the bone-anchored hearing aid. Some of the same makers of dental implants also produce these bone-anchored hearing aids with shape, diameter, thread design and interface very similar to dental implants. Despite the presence of bacteria, minimal soft tissue reactions are seen in these types of titanium implants[33] yet most failures occur because of a lack of osseointegration and not a bacterial challenge.[34] Although these implants do not face the same bacterial profiles as in the mouth they still experience partial or full failure. In addition, it is interesting to note that despite the lack of soft tissue reaction in these types of implants there is histological evidence of soft tissue presence to the first thread of the implant,[35] which echoes the presence of bone loss to the first thread seen in dental implants. If we look outside the mouth and into the body, many models have shown a break in the titanium oxide buffer that in dentistry has been thought to be impenetrable. This should give perspective and possibility for alternative routes for peri-implant bone separation.

Metal Hypersensitivity to Titanium

Patch testing for most metals has been a reliable source of confirmation of metal allergy,[36] especially for metals that form haptens such as nickel, chromium,

platinum and palladium. However, the results of this test are not clear with titanium.[37] Metal ions can trigger type IV immune responses either directly as haptens, or through the binding of albumin or other serum components.[38] Chromium, platinum and palladium are found in some titanium alloys and there is evidence to support type IV hypersensitivy reactions to failed titanium joints. Monoclonal antibody labeling from tissue surrounding failed joints showed abundant macrophages and T lymphocytes in absence of B lymphocytes.[39] The presence of titanium oxide as a food additive and pigment source is widespread. It is used in dermatological products, toothpaste, icing, salad dressing, chewing gum, candy, milk, mayonnaise, marshmallows, powdered milk, tattoo ink and paints, all of which have created many possible routes of exposure outside of dental implants.[40-43] Despite the ubiquitous opportunities for exposure, there are very few documented cases of titanium hypersensitivity.[44] The majority of documented hypersensitivity reactions are attributed to the other metals that may be found in titanium alloys where patch tests are done confirming a reaction to all but the titanium metals.[45,46] With dental implants however, the predominant message in review of the literature is that there is little evidence of an allergic reaction[47] nor a foreign body reaction to intact titanium structures.[48]

Foreign Body Tolerance Model

Examination of interleukin and cytokine profiles around dental implants has offered an argument for an immune system balance or tolerance model. Symptom-free implants have been shown to have profiles with reduced inflammatory cytokine levels as well as immune response dampeners.[49] It has been reported that the cytokine and pro-inflammatory profile of healthy teeth and healthy implants do not differ.[50] When contrasted with the cytokine and interleukin profiles of patients with ailing implants, an argument can be made for intolerance or a loss of balance. However, there is emerging evidence of increased pro-inflammatory cytokine production around clinically healthy dental implants.[51] The idea of immune imbalance and subsequent complication of the foreign body reaction with a complicating bacterial and/or viral component has also been introduced.[52,53] Currently the evidence is clouded by confounding variables, old ideas and accepted disease models.[54] The pathological changes around peri-implant tissues may be related to a disruption of balance between a well-tolerated foreign body and its surrounding biological and bacteriological components.[52,55] This complicated balance is still poorly understood and challenged by evidence in support and in opposition. Still, considering the behavior of orthopedic implants, there is some evidence that dental implants may behave similarly, albeit on a smaller scale, and with the added microbial challenge.

Symptom-free implants have been shown to have profiles with reduced inflammatory cytokine levels as well as immune response dampeners.

Conclusion

It has been shown that titanium can elicit some form of foreign body reaction under specific conditions. The titanium oxide layer so important in osseointegration as well as in protection from the bone can at times break down and offer itself to different forms of corrosion. Titanium is ubiquitous in all forms yet the majority of literature does not argue for its allergic potential. Serious challenges can be made to accepted models of peri-implantitis as either a primary cause or secondary cause in implant failure when looking outside the mouth. The dental community cannot be so focused on the oral cavity to dismiss the activity of titanium in the remainder of the body. If we accept the parallels between dental implants and orthopedic implants then we may also accept the possibility of dental implants as foreign bodies or at least capable of eliciting a foreign body response. Theories explaining well-tolerated dental implants and poorly tolerated implants are emerging and should be included in the discussion of peri-implant bone loss. ■

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Implant Treatment Planning: Endodontic Considerations

Krikor Simonian, DDS; Alon Frydman, DDS; Fernando Verdugo, DMD, PhD; Rafael Roges, DDS; and Kian Kar, DDS, MS

ABSTRACT Implants are a predictable and effective method for replacing missing teeth. Some clinicians have advocated extraction and replacement of compromised but treatable teeth on the assumption that implants will outperform endodontically and/or periodontally treated teeth. However, evidence shows that conventional therapy is as effective as implant treatment. With data on implants developing complications long term and a lack of predictable treatment for peri-implantitis, retaining and restoring the natural dentition should be the first choice when possible.

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Scientific evidence has established dental implants as a predictable, and often the preferable, treatment option for replacing missing teeth. The last decade has seen an explosion in popularity of implant therapy with both clinicians and patients, partly because of the high implant success rate, but also because of corporate marketing strategies and economic forces.[1]

As a result, challenging and time-consuming periodontal and endodontic care has fallen out of favor for some clinicians and has been replaced with extraction and implant placement as a quick fix.[2] The rationale behind this choice is the questionable assumption that implants will perform better in the long term than periodontally or endodontically treated teeth.

Endodontic Therapy

For decades, endodontic therapy has successfully salvaged teeth that would have been irreparable otherwise. Teeth with pulpal disease or necrosis can be predictably and successfully treated with conventional endodontic therapy, provided that the periodontal status is healthy or treatable, the tooth is restorable and the crown-to-root ratio is favorable.

The goal of endodontic treatment is the treatment and prevention of apical periodontitis.[3] This usually involves removing the diseased or necrotic pulp, cleaning, shaping and disinfecting the root canal system, followed by obturation and sealing of the root canal system to prevent re-infection.[4]

Historically, the success rate of endodontic treatment has been evaluated histologically,[5] bacteriologically[6] or radiographically.[7] Besides having no symptoms, the lack of or reduction of the periapical radiolucency is seen as a favorable outcome. Even with their limitations, conventional or digital radiography[8,9,10] are still the primary ways of evaluating endodontic therapy. However, the recent addition of cone beam computerized tomography scans to the armamentarium may provide more sensitive and accurate data, which can translate into greater validity.[11]

Endodontic outcome studies have reported varying results due to the large number of variables involved, including the expertise of the clinician, root canal technique utilized, tooth type, use of rubber dam, concentration and type of irrigant, use of and type of intracanal medications, apical extent, apical diameter, single versus multiple appointments, etc.[3]

Successful initial endodontic therapy has been established by numerous studies with pooled long-term survival rates of 92 percent after six years.[12]

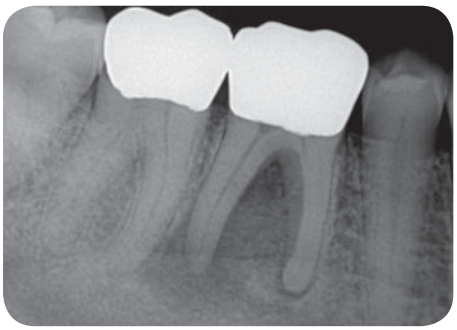

FIGURE 1A. Patient presents with a large periapical radiolucency on the distal root and smaller radiolucency on mesial root.

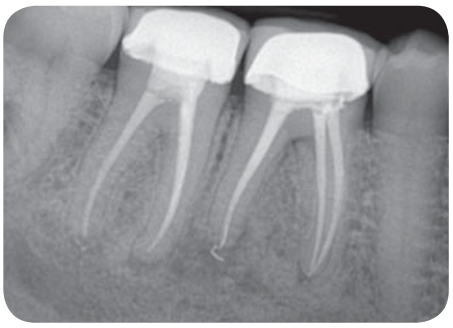

FIGURE 1B. One year recall after nonsurgical initial endodontic treatment demonstrating healing on both roots. (Image courtesy of Natalie V. Finn, DDS.)

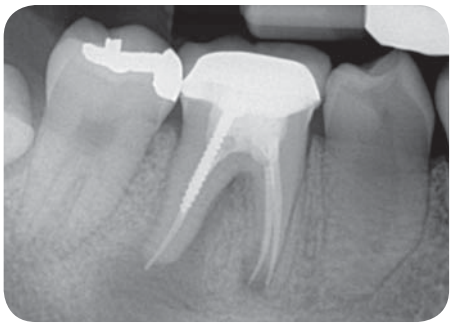

FIGURE 2A. Failing, inadequate endodontic treatment with large periapical radiolucency on the distal root and smaller lesion on the mesial root.

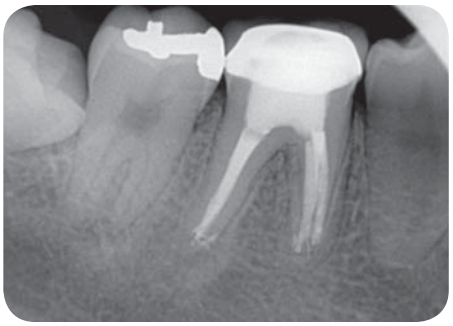

FIGURE 2B. One year recall after nonsurgical endodontic re-treatment demonstrating radiographic healing. (Image courtesy of Natalie V. Finn, DDS.)

FIGURE 3A. Failing, inadequate endodontic treatment with large periapical radiolucency.

FIGURE 3B. One year recall after nonsurgical endodontic re-treatment. (Image courtesy of Howard Liu, DDS.)

The criteria for success in endodontic treatment is the elimination and prevention of apical periodontitis.[13]

Several large-population epidemiologic studies have evaluated the survival of endodontically treated teeth. In 2001, on a subset of 44,613 root canal treated teeth, Lazarski reported a 94.44 percent retention rate over three and a half years.[14] In 2004, Salehrabi and Rotstein looked at 1,462,936 teeth assessed over a period of eight years after initial endodontic treatment and

FIGURE 4A.

FIGURE 4B.

FIGURES 4A and **B.** Failing inadequate endodontic treatment with large periapical radiolucency. Initial treatment was performed after trauma.

FIGURE 4C. Nonsurgical re-treatment was done with MTA apical filling and composite restoration.

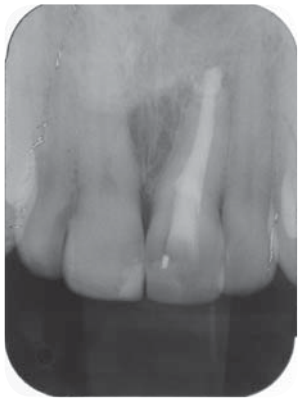

FIGURE 4D. One year recall.

reported a 97 percent retention rate.[15] In a study of 1.56 million teeth treated with nonsurgical endodontic therapy in Taiwan, Chen reported a five-year survival rate of 93 percent[16] (**FIGURE 1**).

Questionable endodontic prognosis usually develops after initial attempts to treat disease fail.

When a periapical lesion persists, the root canal treatment is considered failed even if the tooth is functional. The cause of failure is thought to be continued intraradicular infection due to missed or under-instrumented canals (**FIGURE 2**), cystic lesions, foreign-body reactions from endodontic materials extending beyond the apex[17] and sometimes poor or inadequate treatment[18] (**FIGURE 2**).

Multi-rooted teeth have shown to have a poorer prognosis than single-rooted teeth for successful endodontic therapy.[19] Over or under filling the canals can also negatively affect treatment outcomes[20] (**FIGURE 3**). In 2001, Siqueira stated that even well-treated root canals may fail due to "extraradicular and/or intraradicular infections and intrinsic or extrinsic nonmicrobial factors."[21]

When root canal treatment fails, the clinician is faced with a dilemma: re-treat with surgical or nonsurgical endodontic therapy or extraction with or without implant treatment. The clinician needs to evaluate the reason(s) for the failure and the treatment options that address the initial treatment deficiencies (**FIGURE 4**).

In a systematic review, Torabinejad et al. found an 83 percent functional success rate for nonsurgical re-treatment and a 71.8 percent rate for endodontic surgery at four- to six-year follow-up.[22]

The authors noted that surgical treatment had better outcomes short term, however, this success rate declined over time, whereas teeth treated with nonsurgical modalities demonstrated increased success long term. Further complicating prognosis of re-treatment are factors such as apical lesions,[23] molar teeth[24] and the presence of perforations.[23]

One factor that seems to play a decisive part in the prognosis of endodontic re-treatment is the preservation of the original anatomy of the root canal system. Gorni and Gagliani looked at 452 re-treated teeth and classified them into two categories: teeth with the anatomy modified during previous endodontic treatment (root-canal morphology altered) and teeth in which no significant anatomical changes were made during the earlier endodontic therapy (root-canal morphology respected). The re-treatment success of the altered anatomy group was 47 percent, while that of the morphology respected group was 86.8 percent.[25]

Some teeth will need surgical endodontic therapy regardless of how well the nonsurgical treatment is executed. This group includes teeth with extraradicular calculus,[26] extraradicular infections particularly actinomyces,[27] extraradicular biofilm, cysts and foreign bodies such as the pulse granuloma.[28]

Surgical endodontics has become microsurgical endodontics over the last few decades. The incorporation of the surgical operating microscope in recent years has provided the endodontist with enhanced visibility and access. Other improvements include microsurgical instruments, ultrasonic instruments,

mineral trioxide aggregate (MTA) cement[29] and microsurgical suturing. These microsurgical techniques have elevated the rates of endodontic surgery success to approximately 90 percent.[30,31,32]

When making a decision whether to retain or extract a tooth, the clinician has to evaluate the endodontic as well as periodontal and restorative condition of a tooth and then come up with a prognosis. This, in turn, has to be compared to an implant and a cost/benefit assessment made. One of the issues complicating the comparison of endodontic and implant treatment outcomes is the fact that different criteria has been used in the literature.[1] Whereas continuing osseointegration of an implant regardless of bone loss or other complications is considered a positive outcome, endodontically treated teeth are subjected to stricter guidelines. Radiographic healing and symptom-free status are used as necessary conditions for success instead of the mere "survival" used for implants.

In a university-based, long-term research study using more uniform guidelines, Doyle et al.[33] showed that endodontically treated teeth had an 84 percent positive outcome, while the rate for implants was 74 percent. While both treatments had similar survival rates, implants had more complications, thus a lower success rate, requiring further intervention.

Another factor often ignored is the training and clinical experience of the clinician. In a systematic review, Torabinejad et al.[34] noted that in the scientific literature the overwhelming majority of implant therapy was provided by specialists, while most endodontic treatment was performed by general practitioners. This may have skewed the published success rates in favor of implants. A number of studies have shown that the expertise of the surgeon is a significant factor in the success of implant therapy, with inexperienced practitioners exhibiting twice as many failures.[35,36] Similarly, endodontists achieved an impressive 98.1 percent tooth survival rate, compared to 89.7 percent for general practitioners.[37] This information should be added to any debate about the scientific data on the success of implants and endodontics.

Teeth with pulpal or periapical disease frequently have multiple factors affecting their outcome. The restorative prognosis of a tooth is affected not only by endodontic infection, but often with periodontal issues and weakened tooth structure as well. Scientific data show that a majority of failures of root-canal treated teeth are due to prosthetic reasons.[38] Aquilino and Caplan[39] reported that endodontically treated teeth that were not restored with crowns were six times more likely to be lost than those that were crowned. This finding is also supported by the large epidemiological studies.

Studies have shown that the expertise of the surgeon is a significant factor in the success of implant therapy, with inexperienced practitioners exhibiting twice as many failures.

In a systematic review by Iqbal and Kim,[40] it was shown that both single implants and endodontically treated teeth restored with complete coverage crowns had identical survival rates. Therefore, the authors recommended that the decision to treat or to replace a tooth with an implant should be based on factors other than treatment outcome.

When there is endodontic failure and a decision has been made to replace the tooth with an implant, the clinician has to consider the possible effect of a periapical lesion on the implant. While some studies report high success rates in immediate implant placement into periapically infected sites,[41] others have shown that even in delayed placement, sites with a history of periapical disease developed significantly higher rates of complications and retrograde peri-implantitis.[42]

Retrograde Peri-implantitis

Retrograde peri-implantitis is a symptomatic radiolucency that develops at the apical portion of an otherwise well-integrated dental implant. Up to a 2 percent incidence has been reported.[42] While a number of putative etiologic factors have been proposed, including mechanical or thermal trauma[43] and microbial or viral[44] contamination, solid evidence for a cause or multiple causes is still lacking. However, there are data showing that the dental history of a future implant location is of considerable significance. In a retrospective study, Lefever et al.[42] reported that when an extracted tooth had a history of endodontic treatment, even when there was no detectable radiographic lesion, the incidence of retrograde peri-implantitis was four times higher (8.2 percent) than in teeth without previous endodontic treatment. When the extracted tooth had a periapical lesion, that risk was seven times higher (13.6 percent). More remarkably, the authors reported that when either of the neighboring teeth demonstrated periapical pathology, in 25 percent of cases the implant developed a periapical lesion as well.

Conclusion

There is no question that implant therapy is one of the greatest advancements in dentistry. However, it is not the panacea that some have

advocated. Implant therapy has its own unique challenges and complications, which are not well understood. The treatment of ailing implants is unpredictable and often ineffective. Therefore, caution must be exercised when deciding to extract a treatable tooth in favor of implant placement.

Based on current scientific evidence, in most cases when a tooth with endodontic disease is restorable and periodontally sound, root canal therapy or re-treatment should be performed first. When a tooth has multiple factors affecting treatment outcome, the cost versus benefit should be assessed in addition to the strategic value of the tooth to the overall dentition and the treatment goals of the patient. Immediate implant placement into an infected periapical site is best avoided. Apical pathology on adjacent teeth should be addressed prior to implant surgery. Preserving the natural dentition is the goal of dentistry. If a tooth is missing, irreparable or nonrestorable, the restoration would require multiple treatments with questionable prognosis, or the tooth would hinder the overall treatment plan, implant therapy should be considered. ■

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Teeth Versus Implants: Mucogingival Considerations and Management of Soft Tissue Complications

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ABSTRACT Soft tissue complications around dental implants occur with an incidence between 1 and 7 percent, and the treatments for these have not been as well studied, understood or as predictable as with similar complications associated with teeth. These complications include recession, fenestration/dehiscence defects, gingival inflammation/proliferation and fistulas. This paper compares and contrasts important mucogingival considerations between teeth and implants. Diagnosis, treatment and prevention of some of the more common soft tissue complications are presented.

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The use of dental implants in clinical practice is growing exponentially with great success. The U.S. dental implant market is expected to reach a value of more than $2 billion by 2021 as compared to approximately $900 million in 2012. In 2012, it was estimated that a total of 1,260,000 dental implant procedures were performed in the U.S. based on sales, and this number is expected to double within 10 years.[1]

As more dental implants are placed, however, more complications can and will occur. Yet, our understanding about how to deal with those complications is lacking, because they have not been as well studied.

FIGURE 1A.

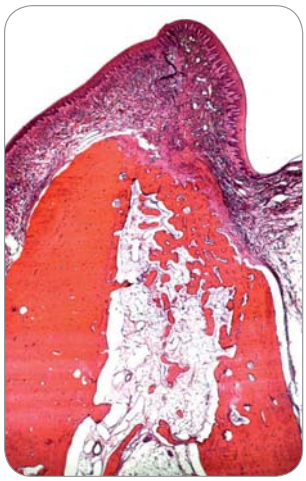

FIGURE 2. Eight weeks.

FIGURES 1 and **2.** Extraction defect histology after one and eight weeks demonstrating loss of bone height and width due to bone remodeling. (Photos courtesy of Maurício Araújo, DDS, MSc, PhD.)

FIGURE 3. The thick biotype is characterized by a dense gingival tissue, wide zone of attached gingiva, flat gingival topography suggesting a thicker alveolar architecture and short blunted interproximal papilla surrounding a square tooth form.

The mucogingival considerations and soft tissue complications that can occur around teeth and implants are somewhat similar. However, there are unique considerations in their clinical presentation and the techniques and predictability for their treatment.

A good number of soft tissue-related implant complications can be attributed to physiologic changes that occur following tooth extraction as opposed to the actual placement of an implant. In addition, loss of bone and soft tissue can occur before tooth extraction due to periodontal disease, periapical pathosis and trauma. Loss of bone and soft tissue can also occur during the tooth extraction process. It is well documented that extraction sites undergo three basic phases of healing, beginning with the inflammatory phase, followed by the proliferation phase and culminating with the modeling/remodeling phase.[2,3] In the modeling phase, there is reduction in the alveolar ridge dimension, both in height and width, that can challenge soft tissue esthetics and long-term maintenance around dental implants (**FIGURES 1** and **2**). Most of these changes occur during the first year following tooth extraction, where the width of the residual ridge may decrease by more than 50 percent.[4] Clinicians must therefore consider this issue when deciding to replace a natural tooth with an implant, as adjunctive procedures are often necessary to compensate for these alveolar bone changes and ideal restoration of the hard and soft tissue complex is often not attainable.[5] This is especially critical in the esthetic zone.

The decision to retain or to replace a tooth with a dental implant is often complex because the decision is multifactorial and evidence-based guidelines are limited and vague.[6-8] Distinct differences exist with what defines a successful outcome within the interrelated disciplines of periodontics, endodontics, restorative and implant dentistry, making evidence-based comparisons between treatment options difficult. In implant dentistry, there is a lack of general consensus on which clinical parameters define success.[9-11] In contrast, the standard for successful endodontic treatment in the dental literature is resolution of the periapical periodontitis[12] and the standard for successful periodontal therapy is pocket closure <5 mm,[13] elimination of bleeding on probing (BoP) to a level <25 percent[14] and maintenance of a high standard of plaque control.[15] In addition to these factors, the ability to adequately restore a tooth, the patient's financial situation including insurance coverage, the patient's psychological and social attributes and the clinician's training, experience and comfort level must also be considered in the treatment decision.

It must be recognized that implants are associated with both short- and long-term complications that often require additional surgical intervention to resolve. Treatment of these complications is poorly understood, especially in the case of peri-implant diseases. It is also unpredictable, as in the case of gingival recession repair and peri-implant bone repair. In addition, the complication of morphologic tissue changes in the years following dental implant treatment may require modification of the prosthetic restoration.[16] Peri-implant tissue loss and further alveolar ridge resorption can lead to metal exposure of the abutment or implant, unsightly interproximal spaces, food impaction, embarrassing escape of saliva and air, and compromised speech.

According to the American Dental Association's Principles of Ethics and Code of Professional Conduct,[17] the primary goal of treatment should be for patient benefit and the patient must be included in the decision-making process and provided all the risks, benefits and alternatives to treatment. This is also a legal requirement for obtaining informed consent. Therefore, despite any real or perceived differences in treatment outcomes, all viable treatment approaches should be presented. Failure to do so undermines

FIGURE 4. The thin biotype is characterized by a delicate and friable gingival tissue with a more pronounced scallop shape, suggesting thin underlying alveolar bone, a small zone of attached gingiva, and long, pointy interproximal papilla surrounding a tapered tooth form.

FIGURE 5. The mucogingival junction (black lines) delineates the separation of the alveolar mucosa with the keratinized gingiva.

the legal concept of "informed" consent, increasing the risk of successful litigation against the clinician if treatment outcomes using implants are unfavorable.

Mucogingival Considerations Around Teeth and Implants

Teeth and Tissue Biotype

The periodontal or gingival biotype has been recognized as an important factor in predicting outcomes following periodontal surgery.[18] The literature describes two general types. Thick biotype is characterized by a dense gingival tissue, wide zone of attached gingiva, flat gingival topography suggesting a thicker alveolar architecture and short, blunted interproximal papilla surrounding a square tooth form (**FIGURE 3**). In contrast, thin biotype is defined by a delicate and friable gingival tissue that is almost translucent in appearance.[19] It has a more pronounced scallop shape suggesting thin underlying alveolar bone often with underlying bone fenestration and dehiscence defects, a small zone of attached gingiva and long, pointy interproximal papilla surrounding a tapered tooth form (**FIGURE 4**).[20,21] The gingival biotype is influenced by the shape, size and location of teeth as well as gender and age and appears to be genetically determined.[22]

Recognition of the biotype allows the clinician to better predict soft tissue behavior and avoid unexpected outcomes associated with various disease conditions following surgical procedures. It is also important to recognize that patients may present with a mixed thin and thick biotype with regional differences influenced by the shape, size and location of the teeth. Therefore, biotype assessment is generally site specific. For example, the biotype could be considered thin over a prominent maxillary canine root and thick around the adjacent incisors.[21,23]

A thick biotype associated around teeth with periodontal disease tends to lead to periodontal pocketing in conjunction with intrabony defect formation with minimal recession. In contrast, a thin biotype tends to exhibit less pocket formation and more recession.[24] The biotype can influence diagnosis of disease because progressive attachment loss can manifest as recession often with only slight-to-moderate periodontal pocketing. The biotype also has implications with periodontal therapy where it is believed that scaling and root planing is generally more effective around teeth with thin biotypes whereas thick biotypes more often require pocket elimination surgery.[23]

With a thick biotype, studies have shown a greater rebound of tissue growth following crown-lengthening, often dictating more aggressive tissue resection during surgery.[25] A thick biotype has also shown to be beneficial with less tooth recession occurring during orthodontic tooth movement.[26-27] In contrast, a thin biotype is associated with less favorable outcomes following mucogingival surgery to achieve root coverage.[28-29]

Implants and Tissue Biotype

It is well accepted that soft tissue esthetics around implants can be managed more predictably in thick biotype environments. A thin biotype is usually associated with thin buccal plates.[30] Following tooth extraction, sites with thin biotypes, defined as thin gingival tissues and thin buccal plates, exhibit more buccal bone loss than sites with thick biotypes.[31] This results in increased gingival recession that may diminish soft tissue esthetics around implants. A greater prevalence of papilla presence around single-tooth implants adjacent to natural dentition is often seen with thick biotypes and a decreased prevalence of papilla; generally more recession is found with thinner biotypes.[32]

The biotype should always be taken into account when planning for implants, especially in the esthetic zone. In a patient with a high smile line where a thin biotype is present in the esthetic zone, all attempts should be made to retain teeth as opposed to removing and replacing them with implants. When teeth cannot be retained in thin biotype situations, adjunctive procedures, such as the addition of an interpositional connective tissue graft, may be beneficial to modify the phenotypic expression of the biotype and decrease the risk of recession and papilla loss.[33,34]

Relevance of Keratinized Gingiva Around Teeth

The keratinized gingiva extends from the gingival margin to the mucogingival junction (MGJ). It consists of both the free and attached gingiva. The MGJ delineates the separation of the alveolar mucosa with the keratinized gingiva (**FIGURE 5**). In 1948, Orban described the MGJ as a scalloped line separating the gingiva from the lining mucosa.[35] Recognition of the MGJ is an important

component in a thorough periodontal evaluation, as it is commonly used to determine the need for and type of periodontal procedures, as well as outcome assessment following gingival augmentation surgery. The MGJ can be determined visually with or without histochemical staining or functionally by moving the alveolar mucosa coronally toward the gingiva using a horizontally positioned periodontal probe (roll test). It has been determined that all of these methods are accurate in assessing the location of the MGJ.[36]

The need for keratinized gingiva around teeth to establish and maintain health remains controversial. Lang and Loe[37] examined the width of keratinized gingiva on 1,406 tooth surfaces in 32 dental students over a six-week period. They found persistent inflammation despite effective oral hygiene in areas with minimal to no keratinized gingiva. The authors suggest that a minimum of 2 mm is needed to maintain gingival health. In contrast, a study using 16 dental, dental hygiene and dental assisting students and faculty members over a 25-day evaluation period found no apparent difference in clinical indices between sites with minimal and appreciable keratinized gingiva width.[38] In a five-year longitudinal study, Wennström surgically removed the entire zone of gingiva around 26 canines and premolars in the mandibular jaw of six patients. He found that with carefully supervised and controlled oral hygiene, the lack of attached gingiva did not lead to an increased incidence of soft tissue recession.[39] In another longitudinal study, recession was evaluated in 25 subjects. The study found minimal changes over a five-year evaluation period and questioned the need for attached gingiva to reduce the risk of attachment loss.[40] Another longitudinal study evaluated the facial gingival surfaces over cuspids and bicuspids in 20 patients over five years. The study found that areas with minimal to no attached gingiva did not lead to more attachment loss when compared with sites that had 2 mm or more.[41] Many studies questioning the need for attached gingiva to maintain periodontal health can be criticized, however, for using a small sample size,[26,38-41] limited evaluation time,[39,42] young healthy subjects,[39,42] nonstandardized probing[41] or clinically unrealistic plaque control and maintenance protocols.[26,41] In a split-mouth longitudinal study, 32 patients were evaluated over a six-year period.

> Despite the scientific controversy, the clinical benefit of establishing an adequate zone of attached gingiva around teeth appears important in clinical practice.

Patients who failed to follow through with the entire duration of the study, including the controlled maintenance protocol, exhibited more recession around sites with inadequate attached gingiva when compared to the sites that were treated with free gingival grafts. This study suggests that with good plaque control, a lack of attached gingiva does not necessarily lead to additional attachment loss. However, sites with inadequate plaque control and inadequate attached gingiva do have an increased risk for additional attachment loss.[43] In another split-mouth study design, 58 teeth in 26 subjects were divided into groups based on the presence and absence of attached gingiva and subgingival full-coverage restorations. The study found no difference between sites with or without attached gingiva in agreement with previous studies,[26,38-41] but did find an increase in inflammation around teeth with minimal zones of keratinized gingiva and subgingival restorations.[44] A review of the literature by Mehta and Lim also confirmed that the width of attached gingiva is not significant to maintain periodontal health in the presence of adequate oral hygiene, however, they did find that thin gingiva around teeth with restorations or undergoing labial orthodontic tooth movement are more susceptible to recession.[27] Wennström also confirmed these findings and concluded that the thickness of the marginal soft tissue may be essential for the prevention of soft tissue recession during orthodontic therapy.[26]

Because a positive correlation exists between the thickness of gingival tissue and quantity of keratinized gingiva,[45] it is logical to assume that gingival augmentation procedures to augment deficient sites are beneficial in clinical conditions with compromised home care or when teeth are to be restored or orthodontically moved. Despite the general consensus that periodontal stability can be maintained with proper plaque control without adequate keratinized gingiva,[46] the clinical reality is that patients seldom perform adequate plaque control and also fail to maintain regular periodontal maintenance.[47] Therefore, despite the scientific controversy, the clinical benefit of establishing an adequate zone of attached gingiva around teeth appears important in clinical practice.

Relevance of Keratinized Mucosa Around Implants

The need for keratinized mucosa to maintain health around implants is also controversial. In a literature review article by Wennström and Derks, 19 articles were selected for analysis. Adequate keratinized mucosa width was defined

as ≥ 2 mm. The authors concluded that there was limited evidence to support the need for keratinized mucosa to maintain health around implants.[48] A long-term retrospective private practice study evaluated the implant health of 60 patients with or without the presence of keratinized mucosa over an average of 10 years. Patients treated with connective tissue or free gingival grafts to increase the quantity of keratinized mucosa and implant health were compared with patients who did not undergo any mucogingival surgery. The results of the study concluded that the lack of keratinized mucosa did not lead to a higher incidence of peri-implant disease with adequate plaque control and regular supportive therapy.[49] In a two-year prospective longitudinal study, 41 patients with 163 implants were followed. Although implant sites adjacent to mobile tissue showed a greater mean amount of recession than sites with a wide zone of attached tissue, the differences were not statistically significant.[51] In a *Cochrane Database Systematic Review*, Esposito and co-workers agreed with these findings and concluded that there is limited weak evidence to suggest that an increase in keratinized mucosa around implants is beneficial.[50]

In contrast, a more recent systematic review by Lin and co-workers[52] found that a lack of keratinized mucosa around implants was associated with more plaque accumulation, tissue inflammation, mucosal recession and bone loss. Included in this review were all cross-sectional, prospective and retrospective human studies examining the effects of keratinized mucosa on implant health with a follow-up of at least six months. Nine hundred and fourteen articles were selected for a full review, out of which 11 were used in the final analysis. In another recent review article, the authors concluded that the presence of an adequate zone of keratinized tissue may be necessary because it promotes better peri-implant tissue health. The authors caution, however, that further controlled trials are necessary to support this statement.[53] In yet another recent systematic review, the authors found that a reduced width of keratinized mucosa appears to be associated with clinical parameters indicative of inflammation and poor oral hygiene. However, the predictive value of keratinized mucosa on these parameters was limited.[54] A cross-sectional study on 200 implants placed and restored at Case Western School of Dental Medicine in Cleveland reported less alveolar bone loss and improved clinical indices of soft tissue health when implants had ≥2 mm of keratinized tissue.[55] Another cross-sectional study on 276 implants corroborated the finding that less recession and bone loss occurs in areas with adequate keratinized mucosa but contradicted the finding that the clinical indices (gingival index, plaque index and pocket depth) were improved. This may be explained by better plaque control measures in one study over the other.[54-56] An increase in plaque accumulation, bleeding, inflammation and soft tissue recession was also reported around implants supporting fixed mandibular full-arch prostheses that had inadequate keratinized mucosa, despite regular implant maintenance and good oral hygiene habits by the patients.[57] Similar findings were reported around implants with inadequate keratinized mucosa supporting overdentures.[58]

> Plaque control around implant-supported prosthetic reconstructions, especially when fixed in clinical situations with severe tissue loss can be very difficult.

Bone and soft tissue remodeling occurs with tooth loss. Therefore, implant reconstructions must often replace the missing teeth as well as the hard and soft tissues. Plaque control around implant-supported prosthetic reconstructions, especially when fixed in clinical situations with severe tissue loss can be very difficult. This is due to the often over-contoured shapes of the prostheses at the tissue-prosthesis interface, which are often cantilevered or extended for esthetics and phonetics. The studies cited suggest that an adequate zone of attached mucosa may facilitate plaque control around these challenging prosthetic reconstructions. In a study on 30 implants in five monkeys, peri-implantitis was experimentally induced using subgingival cotton ligatures. Significantly more recession and slightly more bone loss occurred around implants without keratinized mucosa.[59] This study suggests that the presence of adequate keratinized mucosa may reduce the risk of developing plaque-induced peri-implant disease. In addition, the immunologic parameters can be influenced by the presence or absence of keratinized mucosa. A decrease in prostaglandin E2 (PgE2) levels was found in subgingival sites with wide zones of keratinized mucosa. Because increased PgE2 is associated with greater clinical inflammation, it might be assumed that a wide zone of keratinized mucosa would promote a reduction in inflammatory mediators and thus reduce the risk of peri-implant disease.[60] In addition, some studies suggest that the lack of keratinized mucosa increases the risk for implant failure.[61,62]

It is commonly accepted that the

FIGURE 6. Inflammation associated with the lack of keratinized mucosa on the lingual aspects of the implants.

TABLE 1

Miller Recession Classification[78]

	Clinical Presentation	Expectation	Success Rate
Class I	Recession above mucogingival junction (MGJ) No interproximal attachment loss	Complete root coverage	100%
Class II	Recession beyond MGJ No interproximal attachment loss	Complete root coverage	100%
Class III	Recession to or beyond MGJ Minor interproximal attachment loss	Partial root coverage	50-70%
Class IV	Recession to or beyond MGJ Severe interproximal attachment loss	Unpredictable root coverage	<10%

presence or maintenance of interproximal papilla around dental implants is related to the height of the interproximal bone.[63,64] It has also been reported that the presence of keratinized mucosa around implants is another important factor related to interproximal papilla maintenance.[65] Therefore, an adequate zone of keratinized mucosa may also benefit implant soft tissue esthetics.

Although still controversial in the dental literature, similarly with natural teeth, it is a widely held clinical belief that the presence of keratinized mucosa around implants is also beneficial to maintaining both long-term peri-implant tissue health and soft tissue esthetics (**FIGURE 6**). Therefore, mucogingival surgery to enhance the quality as well as quantity of keratinized mucosa is often needed in conjunction with implant treatment.[66]

Biologic Complications – Diagnosis, Treatment and Prevention

Dental implants have proven to be a reliable and predictable means to replace missing teeth, with favorable long-term outcomes reported in the literature for more than 30 years. Surgical, biologic and mechanical complications, however, do occur, albeit in low percentages.[67] A comprehensive literature review from 1981 to 2001 on implant and implant prostheses complications found a mean incidence of implant loss between 3 and 19 percent, neurosensory disturbance of 7 percent, hemorrhage-related complications of 24 percent, soft tissue complications between 1 and 7 percent, and mechanical complications related to prosthesis repair or maintenance of up to 30 percent.[68] The most frequently reported peri-implant soft tissue complications were fenestration/dehiscence defects, gingival inflammation/proliferation and fistulas.[68,69] In a systematic review of single crowns and implants with a mean follow-up of five years after loading, a 96.3 percent average survival rate was reported. The most common technical complications included screw or abutment loosening with an incidence of 8.8 percent, loss of prosthesis retention with an incidence of 4.1 percent, and prosthesis fracture, both minor and major, with an incidence of 3.5 percent. The incidence of soft tissue complications was 7.1 percent and bone loss greater than 2 mm was 5.2 percent after five years. The most frequently reported soft tissue complications were inflammation, mucositis, bleeding and suppuration, and soft tissue dehiscence.[70] This report will focus on some of the more commonly reported complications associated with the soft tissues surrounding implants, specifically mucosal recession, infection and papilla loss.

Recession Around Teeth

Gingival recession around teeth is defined as apical migration of the gingival margin away from the cemento-enamel junction (CEJ). The etiology of tooth recession can be multifactorial, including anatomic, physiologic and pathologic factors, along with trauma and oral hygiene issues. Anatomic factors can be developmental, e.g., clinical situations of alveolar bone fenestration and dehiscence, malpositioned teeth, pathologic tooth eruption or abnormal tooth shapes.[71] Anatomic factors can be acquired physiologically, such as when teeth are orthodontically positioned beyond the perimeter of the alveolar process, or pathologically as in the case of bone resorption due to periodontitis. Vigorous toothbrushing,[72] aberrant frenum attachments, occlusal trauma and oral piercings[73] are all examples of trauma-induced recession. Oral hygiene can be a factor because increased recession has been reported in patients with good rather than poor oral hygiene.[74] Substance abuse can also induce recession.[75,76] Recession and bone loss have been shown to be more prevalent in alcoholics and is also caused by cocaine placed on the gingiva. Using data collected from the third National Health and Nutrition Examination Survey (NHANESIII), it has been estimated that 23.8 million people have one or more tooth surfaces with gingival recession ≥3 mm, or approximately 23 percent of the population. The prevalence, extent and severity of recession increase with age and are worse in males than females.[77]

Multiple classifications for tooth recession are available to assist the clinician in diagnosing and treating gingival recession around teeth.[78-81] The most widely used is the classification by Miller,[78] which considers the extent of recession

FIGURE 7.

FIGURE 8.

FIGURES 7 and **8.** An interpostional connective tissue graft with a coronally advanced flap was used to correct the recession and mucogingival defects over the lower central incisors.

FIGURE 9.

FIGURE 10.

FIGURES 9 and **10.** Malpositioned implants can lead to loss of bone and soft tissue.

in relationship to the mucogingival junction and the presence or absence of interproximal bone (**TABLE 1**). According to the Miller classification, 100 percent root coverage can be expected in Class I and II defects with less coverage expected in Class III defects and little to no coverage expected in Class IV defects. In the periodontal literature, numerous surgical techniques have been investigated for root recession coverage over the last 50 years, including free gingival grafts, connective tissue grafts, allografts, coronally positioned flaps, pedicle grafts and guided tissue regeneration.[82] The connective tissue graft in conjunction with a coronally positioned flap appears to be the most predictable way to achieve root coverage[74,83,84] (**FIGURES 7** and **8**).

Recession Around Implants

In stark contrast, very little is known about the diagnosis, etiology, prevalence or treatment of recession defects around dental implants. A classification system to diagnose implant recession does not exist. In addition, very few prospective studies and only a small number of clinical case reports have been published on treatment.[85-87] Even the term "recession" around implants is confusing. Recession around teeth is defined as apical migration of the gingival margin from the CEJ. Because a CEJ does not exist around an implant, a standard reference point for the purpose of diagnosis, evaluation and study comparisons is not well defined or universally accepted. Moreover, there are significant morphologic differences between periodontal and peri-implant tissues.[88] When recession occurs around a tooth, a loss of attachment typically has occurred. This is not necessarily the case around a dental implant. Therefore, for purposes of this report, implant recession refers to the migration of the peri-implant mucosa apical to an ideal position in relation to the adjacent dentition.

The etiology of mucosal recession around implants appears to be multifactorial. In a systematic review on the frequency of advanced recession following single immediate implant treatment, Cosyn and co-workers[32] concluded that soft tissue recession could be expected following immediate implant placement and that multiple factors contribute to the phenomenon. Implants that are buccally inclined, or placed in close proximity to a cortical plate or implants that are oversized for the specific site, can promote loss of bone and subsequent mucosal recession[90] (**FIGURES 9** and **10**). A five-year retrospective study on 47 patients receiving single maxillary incisor immediate implants and immediate provisionalization concluded that implant diameter, gingival biotype, surgical technique and the reason for original tooth loss influence the amount of gingival recession.[91] A two-year longitudinal prospective study on recession around dental implants suggests that peri-implant soft tissue recession might be the result of soft tissue remodeling to establish a biologic width.[51] The study also found that most recession occurs within six months of prosthesis delivery. A greater amount of implant recession was found in women than men, in the mandible than in the maxilla, and at lingual sites than in facial sites.[51]

Treatment of mucosal recession around dental implants is elusive. A review of the literature only uncovered three prospective trials. In a six-month prospective study, 10 patients were treated with an overcompensated coronally advanced flap in conjunction with an interpositional connective tissue graft. These patients had a mean mucosal recession of 3 mm prior to surgery. A mean "over" coverage of the recession defect up to 1.2 mm was obtained immediately following the procedure. After one month, a mean coverage of 75 percent was achieved and after six

months, 66 percent was retained.[92] In a study by Zucchelli and co-workers, 20 patients with a mean mucosal recession of 3 mm were also treated using a coronally advanced flap in conjunction with an interpositional connective tissue graft harvested from the palate. In this study, the original restorations were removed in preparation for the procedure and replaced with new ones following surgery. The authors reported a statistically and clinically significant improvement in implant recession coverage with a mean coverage of 96.3 percent. However, complete coverage was only achieved in 75 percent of the treated sites.[93] It should be noted that subjects recruited for this study also had a mean recession of about 3 mm and no interproximal attachment loss on the adjacent teeth. This clinical situation represents a Miller Class I or II type of defect where 100 percent coverage is routinely achieved around teeth. In a one-year prospective pilot study, 16 patients were treated with a coronally advanced envelope flap in conjunction with a thick interpositional connective tissue graft harvested from the maxillary tuberosity. The results of the study achieved approximately 90 percent mean recession coverage but only nine out of 16 patients (56 percent) achieved complete coverage. It should also be noted that the preoperative mean recession was only 2 mm and similar to the previous studies cited, minimal to no interproximal bone or papilla loss was present adjacent to the implant recession defects. A few case reports have introduced a technique involving the complete removal of the implant abutment and restoration, allowing the tissues to naturally overgrow and resubmerge the implant with or without the addition of a connective tissue graft.[90,94] This technique may hold some promise for the future but additional studies are warranted to determine its predictability and efficacy.

FIGURE 11.

FIGURE 12.

FIGURES 11 and **12.** An interpositional connective tissue graft within an envelope flap was used to cover the exposed titanium abutment in a single procedure.

FIGURE 13.

FIGURE 14.

FIGURE 15.

FIGURE 16.

FIGURES 13–16. Multiple surgical procedures were required to achieve coverage of the exposed titanium abutment. Note the divided amalgam tattoo associated with the semi-lunar pedicle flap procedure. (Final restoration by Glenn Bickert, DDS.)

A systematic review of the literature for the Cochrane collaboration group[34] attempted to answer the question of what are the most effective techniques for soft tissue management around implants. Only six trials in the literature were eligible for review after a thorough and exhaustive search was performed. The authors concluded that there is insufficient reliable evidence to provide a recommendation on which is the most effective soft tissue augmentation technique around dental implants. Prosthetic protocols such as platform-switching show some promise in minimizing crestal bone loss and recession,[89] but further research is needed before any definitive conclusions can be made.[130]

Mucosal recession around an implant in the maxillary left canine position exposing approximately 3 mm of the titanium abutment is shown in **FIGURES 11** and **12**. An envelope flap with an interpositional connective tissue graft harvested from the palate was performed. After a single surgical procedure, complete coverage of the exposed titanium

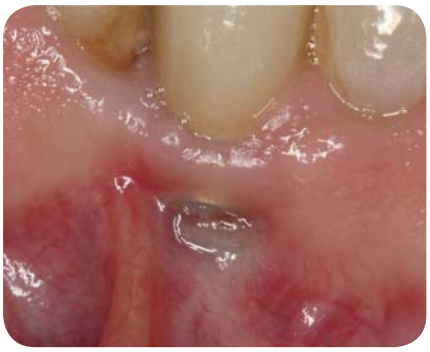

FIGURE 17. Soft tissue fenestration over an implant.

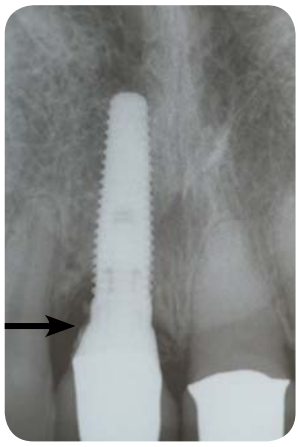

FIGURE 18. Subgingival cement retention on the mesial surface of the implant and abutment.

abutment was achieved. An implant was placed in site No. 8. Following final abutment connection four months after implant placement, mucosal recession occurred exposing approximately 2 mm of the titanium abutment. Three separate surgical procedures were performed to achieve recession coverage, including a coronally advanced flap with an interpositional connective tissue graft, followed by an envelope flap with another interpositional connective tissue graft and finally a semi-lunar advanced pedicle flap (**FIGURES 13–16**). In summary, recession repair around implants when compared to teeth is not as well studied or understood and treatment is not as predictable.

Periodontal and Periapical Lesions Around Teeth

Odontogenic infections are one of the most prevalent diseases and the primary reason patients seek out dental care throughout the world. The most common infection is the periapical abscess (25 percent), pericoronitis (11 percent) and periodontal abscess (7 percent).[95] The periodontal abscess is the third most common dental emergency and is prevalent in patients with untreated periodontitis as well as in periodontal patients in supportive therapy.[96] The microorganisms associated with a dental abscess are predominantly anaerobic and in the case of the periodontal abscess, they are similar to the pathogens associated with periodontal disease. In the case of the endodontic abscess, many microbiologic similarities with the periodontal abscess can be found but distinct differences do exist.[97,98] The majority of odontogenic infections are anaerobic and polymicrobial, and these infections can be further characterized as chronic or acute.

Invading and multiplying bacteria characterize the acute infection. They are associated with pain, swelling and localized heat production as a result of the initial immunologic response to the invading organism, which is primarily a nonspecific inflammatory reaction, dominated by polymorphonuclear leukocytes. The chronic infection occurs when the microorganisms cease invasion, but are still retained within the tissues. In contrast to the acute lesion, the chronic lesion has little to no symptoms and patients are commonly unaware of the infection. Chronic infection is associated with granulation tissue development and lymphocyte activity. The bacteria in these lesions increasingly become resistant to phagocytosis. The chronic infection often leads to further tissue destruction, commonly seen as radiographic bone loss associated at the apex of an endodontically involved tooth or around periodontally diseased teeth.[98] It is important to understand that an acute lesion can become chronic once drainage is established, and the chronic lesion can transform into an acute lesion when host-bacteria homeostasis is altered. This often occurs following incomplete instrumentation of roots with chronic severe periodontal disease or over instrumentation of the chronically diseased root canal past the apex.

Treatment of the odontogenic abscess involves three basic principles, establishment of drainage, identification and elimination of the infection source, and reconstruction of the tissue damage if needed. Diagnosis and treatment of infections associated with teeth have been well researched in the literature. Treatment strategies include mechanical debridement, surgery and systemic antibiotic administration.[98] Treatment of the odontogenic infections is important in overall patient health as some reports suggest that death can occur in untreated conditions.[99]

Peri-implant Lesions

The prevalence of soft tissue complications around implants has been reported to occur between 1 and 7 percent and the most frequently reported are fenestrations and fistula formation (**FIGURE 17**).[68] Infections around implants can occur at any time during treatment. The most common reasons for abscess formation around implants are screw or abutment loosening, retained cement, peri-implantitis and implant failure.[100]

Components attached to an implant fixture often become loose. This includes the prosthetic abutments as well as the cover screws and healing abutments prior to prosthesis delivery. The micro gap between components often harbors bacteria and if components become loose, further colonization can occur.[101,102] Microbes entrapped within this gap can cause infection and fistula formation.[103] Initial treatment of these types of infections involves removal, decontamination and proper reattachment

FIGURE 19.

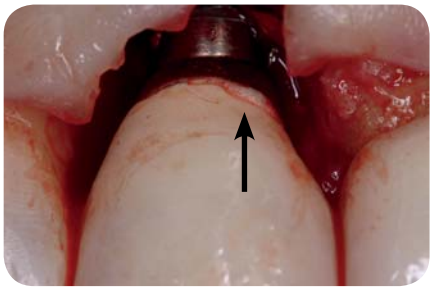

FIGURE 20.

FIGURE 21.

FIGURES 19–21. Subgingival cement along the abutment-crown interface, leading to a buccal fistula and crestal bone loss requiring surgery for removal causing minor soft tissue esthetic compromise.

of the components. Surgical debridement with or without tissue reconstruction may be indicated in situations where tissue damage has occurred. The incidence of this problem can be reduced with careful adjustment of tissue-supported provisional restorations resting against healing screws and abutments during the healing phase, and appropriate component use including a torque wrench during final prosthesis delivery.[100,104]

Incomplete cement removal is a common problem with cement-retained restorations (**FIGURE 18**). The trapped cement can become a foci for infection and can lead to peri-implant disease and even implant loss. Detection of retained cement can be elusive even with radiopaque cements. Subgingival cement on the buccal or lingual surfaces of an implant is not detectable radiographically and clinical detection can be difficult even with supragingival margins.[105] In addition, patients with a history of periodontitis may be more susceptible to cement-induced peri-implant disease.[106] Treatment of this complication obviously involves removal of the cement, which at times requires an open flap procedure for access. As with all surgical reentry procedures around implants, soft tissue esthetics can be compromised following surgery. Therefore, avoidance of cement retention is key. Various cementation techniques have been proposed to reduce the incidence of cement retention.[107] Careful clinical and radiographic evaluation post cementation is required and a one- to two-week follow-up is recommended following prosthesis delivery. Unexplained inflammation and bleeding upon probing during the initial follow-up visit often indicates cement retention. Avoiding cements altogether through the use of screw-retained restorations eliminates this risk. It is apparent, however, that further improvement of clinical protocols for better cement removal is needed. **FIGURES 19–21** demonstrate a fistula over an implant as a result of subgingival cement retention. After unsuccessful nonsurgical debridement, the cement was removed with an open flap surgical procedure using an air-abrasive device. Slight recession and minor loss of papilla occurred as a consequence of surgical re-entry.

Diagnosis, etiology and treatment of peri-implantitis are beyond the scope of this paper and addressed elsewhere in this issue. It is widely accepted that bacterial-induced peri-implant diseases can lead to bone loss as well as acute infections and fistula formation.[108,109] Treatment of acute infections caused by peri-implant disease involves a similar protocol followed for teeth where drainage is initially established followed by removal of the infection source and surgery to reconstruct tissue damage if needed.[110] Again, surgery around implants to treat these problems can lead to esthetic compromise. Studies suggest that patients with periodontitis have an increased risk of developing peri-implant disease. Therefore, establishment of periodontal health in the partially edentulous patient, prior to implant placement, is strongly advised to prevent these types of complications.[111] It can be argued that patients with active or recalcitrant periodontitis are not even appropriate candidates for implant therapy.

Implant failure can occur at any time during treatment. Early failures are usually attributed to inadequate diagnosis, improper surgical technique or trauma. Late failures, in contrast, are usually a result of inadequate osseointegration, peri-implant disease or overload.[108] As an implant fails, loss of bone occurs and infections can develop.[111] **FIGURES 22–25** demonstrate a fistula that developed shortly after final abutment connection and placement of a provisional. Cement retention was suspected. Upon removal of the provisional, the implant was also found to be mobile due to cement-induced bone loss and therefore removed. The site was grafted using a mineralized allograft in conjunction with a resorbable membrane to prepare for a second implant procedure. Despite what appeared to be a routine and successful site preservation procedure, severe resorption of the buccal plate occurred, which would not allow for another implant without additional ridge augmentation surgery. The patient, having already undergone multiple surgeries — including a site preservation procedure at the time of tooth removal, placement of the initial implant, and removal of the implant with another site preservation procedure — elected not to have additional surgery and instead pursued a conventional bridge.

FIGURE 22.

FIGURE 23.

FIGURE 24.

FIGURE 25.

FIGURES 22–25. Subgingival cement leading to severe bone and implant loss and an extremely compromised site as a consequence.

Papilla Loss Around Teeth

The gingival papilla is the tissue that fills the embrasure space between adjacent teeth. The interproximal bone, tooth morphology and adjacent tooth contact points influence size and shape of gingival papilla.

Cohen first described the papilla and col histologically. Papilla is composed of keratinized stratified squamous epithelium and the col consists of reduced enamel epithelium that is nonkeratinized or parakeratinized and, therefore, the weakest link and susceptible to breakdown.[112] Classification systems have attempted to identify and describe the loss of papillary height around natural teeth.[113] Open gingival embrasures can develop because of aging, periodontal disease, loss of interproximal alveolar bone height, interproximal contact point alterations, root malposition and triangular-shaped crowns.[114,115] Loss of papilla, especially in the esthetic zone, leads to the appearance of black triangles, which are not only unesthetic but also promote plaque accumulation and debris retention. Therefore, the loss of gingival papilla can adversely affect the health of the periodontium. According to Tarnow and colleagues, the presence of interproximal papilla depends on the distance between the bone crest and interproximal contact. When the distance from the contact point to the crest of bone was 5 mm or less, the papilla was present almost 100 percent of the time. When the distance was 6 mm, the papilla was present 56 percent of the time and when the distance was 7 mm or more, the papilla was only present 27 percent of the time or less.[63] The periodontal biotype has also been suggested as a factor that influences the presence of interdental papilla.[116]

Papilla loss around natural teeth can be managed surgically and nonsurgically. Nonsurgical management includes orthodontic, restorative and prosthetic procedures. Orthodontic treatment can be used to reposition roots and reduce gingival embrasures, lengthen contact points and move the papilla apically, thus enhancing papilla fill.[85,132] Restorative treatment through the use of provisional crowns, for example, can facilitate interdental tissue conditioning before delivery of definitive restorations. Refinement of provisional crowns can induce creeping papilla formation and alteration of interproximal contours of adjacent teeth. Using composites, for example, can apically reposition the contact point reducing the embrasure space. Prosthetic procedures can mimic lost interdental papillae using pink porcelain or resin (**FIGURE 26**).[117]

There are myriad surgical options available for the reconstruction of interdental papillae. These procedures include gingival grafts, palatal roll techniques, pedicle flaps and subepithelial connective tissue grafts with or without apically repositioned flaps.[118-120] Complete and predictable restoration of lost interdental papilla is one of the biggest challenges in periodontal reconstructive surgery. The vast majority of publications researching this topic are limited case reports. Currently, there are no surgical procedures that can predictably restore the lost gingival papilla around teeth.

Papilla Loss Around Implants

Papilla loss is a frequent problem around dental implants. As previously stated, a reduction of the alveolar ridge, both in height and in width, occurs following tooth extraction.[2,3] The loss of papilla is therefore often due to the histomorphometric changes that occur following tooth extraction, as opposed to the actual placement of the implant.

The soft tissues surrounding a dental implant, including the peri-implant papilla, functionally differ from those around a natural tooth. The gingiva adjacent to teeth consists of the sulcular epithelium, junctional epithelial and connective tissue attachment. The junctional epithelial attachment around teeth consists of a physical attachment to the tooth via hemidesmosomes. The connective tissue attachment consists of

FIGURE 26. Pink porcelain is commonly required around implant restorations to replace missing soft tissues and improve esthetics.

TABLE 2

Tooth Versus Implant Histology

	Teeth (Gargiulo et al. 1961)[121]	Implants (Cochran et al. 1997)[123]	Implants (Romanos et al. 2010)[124]
Sulcus depth	0.69 mm	0.16 mm	2.2 mm
Junctional epithelium	0.97 mm	1.88 mm	1.4 mm
Connective tissue	1.07 mm	1.05 mm	2.05 mm
Biologic width	2.04 mm	3.08 mm	5.65 mm

a perpendicular arrangement of collagen fibers inserted directly into the tooth as well as adjacent bone via Sharpey's fibers. The perpendicular fiber arrangement suggests this attachment is functional. The junctional epithelial and connective tissue attachments form the biologic width or "seal," which is an anatomic constant, protecting the tooth against microbial invasion and trauma.[121]

Histologically, the soft tissues around an implant also consist of a sulcular epithelium, junctional epithelium, including the presence of hemidesmosomal adhesion, followed by a connective tissue layer.[88,122-124] In contrast, however, the junctional epithelium does not appear to be a physical attachment. In an experimental study on dogs, the morphology of the peri-implant soft tissues was histologically evaluated in conjunction with a periodontal probe. The study found that during routine gentle probing, the periodontal probe extended to the connective tissue past the junctional epithelium suggesting that a physical attachment of the junctional epithelium does not exist.[125] In addition, the connective tissue fibers adjacent to the smooth titanium collar of a dental implant have a parallel fiber arrangement, further questioning the presence of a physical and protective barrier around dental implants and suggesting the presence of a connective tissue contact instead of a true attachment.[88] Another significant difference between an implant and a tooth is the lack of cementum and periodontal ligament. These histologic differences between the natural tooth and implant may also explain some of the papilla loss associated with implant placement. **TABLE 2** presents dimensions of the biologic width of teeth and implants.

As stated earlier, the anatomic structures that make up the biologic width are an anatomic constant, and their presence has therefore also been confirmed around dental implants.[123-126] The biologic width around implants is physiologically formed, dimensionally stable and structurally constant. Significant changes of each component of the biologic width, however, do occur over time. Alterations of the sulcus depth, junctional epithelium and connective tissue contact were found in a study in dogs when comparing the biologic width at various time intervals before and after loading. Interestingly, despite the dimensional changes of each component, the sum of components remained constant.[126] The biologic width also influences the crestal bone position. The position of the abutment-implant interface (micro gap) with a two-piece implant system determines the crestal bone position.[127] When the micro gap is positioned at or below the alveolar crest, loss of bone occurs. When the micro gap is positioned 1 mm above the alveolar crest, the bone contacts the implant at the smooth-to-rough implant interface. In a one-piece rough surface implant system, crestal bone remodeling is influenced and determined by the smooth-rough junction.[127] The implant-abutment interface is often positioned below the interproximal bone crest especially when the bone crest is irregular or scalloped. Therefore, loss of interproximal bone often occurs. An exception to this is in cases of single tooth implants placed next to adjacent teeth. The adjacent tooth largely maintains the interproximal bone height in this scenario.[128] Furthermore, the disruption of the soft tissue interface that occurs when the abutment is removed and replaced, which typically occurs repeatedly during the surgical and restorative process, has also been reported to induce loss of bone, presumably because of re-establishment of the biologic width.[129] If loss of interproximal bone occurs and the distance between the bone height and restorative contact point is greater than 5 mm, lack of papilla within the embrasure space can also be expected.[63]

Jemt proposed a five-level classification of papilla restoration around single tooth implants in 1997. In brief, a score of 0 describes a complete lack of papilla, a score of 1 is given when less than half the papilla is present, a score of 2 when half or more but not complete papilla is present, a score of 3 when the papilla fills the entire embrasure space and a score of 4 when the papilla is hyperplastic and is in excess.[131]

Various techniques and procedures have been proposed to establish, maintain or reconstruct papilla around implants. Numerous publications have proposed orthodontic treatment to reposition or transpose teeth for proper space development or bone defect repair, or to extrude teeth along with the bone and soft tissues in preparation for implant placement.[85,132-133] Presurgical

FIGURE 27.

FIGURE 28.

FIGURE 29.

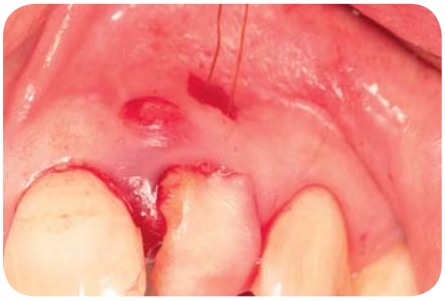

FIGURE 30.

FIGURE 31.

FIGURE 32.

FIGURES 27–32. Tooth extraction with an immediate dental implant, connective tissue and bone graft to minimize site remodeling. Grafting and alteration of interproximal contact points by adjacent restorations lead to an esthetically pleasing result. (Final restorations by Jon Marashi, DDS.)

orthodontic treatment is predictable and relatively noninvasive. Disadvantages include additional cost and treatment time. As previously stated, loss of bone occurs through the remodeling process following tooth removal. Therefore, one might incorporate procedures at the time of extraction that will prevent or at least minimize these changes. In a randomized controlled clinical trial, the placement of a xenograft within extraction sockets markedly reduced the volume of alveolar ridge loss following tooth removal.[134] Multiple studies have demonstrated reduced ridge resorption when bone replacement graft materials were placed within extraction sockets. However, there is no consensus that any one grafting material is superior to another, or that a barrier membrane is necessary. The general consensus from these studies, however, support the ridge preservation procedure as a way to preserve the alveolar bone following tooth removal and minimize the morphologic changes that normally occur.[135] Because the contours of the soft tissue closely follow the topography of the bone, bone augmentation and tissue grafting are often used for the reconstruction of the deficient gingival papilla. Surgical reconstruction techniques include alteration in flap designs,[136] various pedicle tissue graft techniques,[137,138] free tissue grafts[139] and guided bone regeneration.[140] Although there are numerous publications on this topic, the vast majority are only case reports. Maintenance of the papilla around implants is a complex challenge and similar to teeth, reconstruction of the deficient papilla is extremely technique sensitive and unpredictable. This is especially evident with adjacent implants.[141]

Other surgically related techniques that have been proposed to improve papilla maintenance include immediate instead of delayed implant placement,[142] the use of implants with specifically altered design for papilla maintenance, such as a scalloped implant,[143] the incorporation of connective tissue grafts at the time of implant placement[144] or the use of platform switching.[89,130] Still, none of these techniques, alone or in combination, have been found to predictably maintain papilla significantly better than more conventional procedures.[145] Quite often, layered approaches incorporating some if not all of the above procedures are performed in the hopes of achieving an ideal esthetic outcome (**FIGURES 27–32**).

Given the difficulty of preserving or reconstructing papilla around dental implants, various prosthetic procedures have been proposed as a last resort to mask the deficiencies. This includes restoration of adjacent teeth to alter contact points or inclusion of pink restorative materials

to close embrasures and simulate gingival papilla.[146] Prototypic provisional restorations must often be modified during the healing process to accommodate deficiencies of the tissue and be evaluated for esthetics, phonetics and function prior to the fabrication of the final prosthesis. Modifications of the prototype can be evaluated for their effectiveness in alleviating the clinical problems brought on by the tissue loss. Embrasure spaces can be closed, allowing just enough room for hygiene. Pink restorative materials can be used to evaluate esthetics of pink porcelain or composite materials in the final restoration. Tooth forms can be widened, and line angles modified to make a decision on how best to manage the embrasure space caused by the loss of the interdental papilla. In clinical situations that involve extensive osseous resection, it may be wise to delay impressions for the final restoration up to six months following surgery to minimize the risk of additional tissue change with a final prosthesis.

Discussion

The predictable use of dental implants in clinical practice to replace lost or missing dentition is well substantiated in the literature. Implant success rates in the mid to high 90 percent range and similar success rates of implant-assisted prostheses are routinely reported. The advent of dental implants is one of the most significant developments in dentistry this century. Biologic complications, however, do occur, albeit to a minor extent, and the clinician must have a thorough understanding of these problems and be prepared to manage them or to refer them to the appropriate specialist when they do arise. Successful treatment cannot be exclusively determined by functional osseointegration or lack of pathology and pain. An acceptable esthetic outcome, proper phonetics and lack of progressive bone loss, including absence of peri-implant disease, must also be achieved.

The incidence of soft tissue complications around implants is minor, with rates reported between 1–7 percent. The clinical implications of these complications, however, can be dramatic. Severe bone and soft tissue loss around an implant in the esthetic zone in a patient with a high smile line can be devastating. Mucosal recession and loss of interproximal papilla is not only a concern in the esthetic zone, but can also compromise plaque control and promote food impaction, increasing the risk of peri-implantitis and loss of crestal bone. Some amount of mucosal recession and loss of papilla can be expected around implants, as these changes are often associated with tooth extraction and subsequent bone remodeling. Site preservation procedures can and should be used to minimize these changes, especially in the esthetic zone. The tissue biotype must also be considered to accurately predict the soft tissue behavior following surgery, which can impact the overall treatment plan. Thin biotypes may benefit from using interpositional connective tissue grafts at the time of implant placement. Presurgical orthodontic treatment to reposition or extrude teeth with associated tissue, should also be considered, especially with preexisting tissue defects. It should be remembered that surgical reconstructive techniques to repair recession and papilla loss following implant placement are largely unpredictable.

The advent of dental implants is one of the most significant developments in dentistry this century.

Iatrogenic factors can also cause recession and papilla loss. Implants placed too close to the buccal plate or angled too far buccally can lead to mucosal recession. The use of oversized implants for a given space, placing implants too close to adjacent teeth or placing multiple implants too close to each other will also invariably lead to recession as well as papilla loss. In contrast with most other dental procedures, malpositioned implants cannot be easily adjusted or repositioned.[147] Removal of the implant is often the only recourse, which restarts the bone-remodeling cascade, further compromising the site and often precluding the placement of another implant. The patient's clinical condition can be worse than how he or she started.

Loose cover and abutment screws, retained cement and acute exacerbations of chronic peri-implant disease can cause infections around implants. Great care must therefore be exercised to minimize trauma from tissue-supported provisional restorations over healing implants, which can cause loosening of components. Proper use and application of torque on the fixation screws based on manufacturer recommendations must be followed. The use of radiopaque cement that is easily removed is strongly advised. Radiographs should be taken following final prosthesis delivery. A one- to two-week follow-up is recommended, as retained cement will either be radiographically evident or quickly manifest as significant inflammation and bleeding upon probing without the presence of plaque. The use of screw-retained restorations can avoid the problem of retained cement altogether but are more complicated

to fabricate. Establishing periodontal health prior to implant placement is a standard of care. Disease control should always be the primary initial focus of patient treatment. Once disease control has been achieved and implants with their restorations completed, maintenance of the periodontal and peri-implant tissues is then required. A three- to six month maintenance schedule should be followed based on an individual patient risk assessment for recurrent disease.[14,109] In contrast with periodontitis, peri-implant disease must be quickly addressed and aggressively treated. Surgery with appropriate grafting procedures is commonly needed to re-establish crestal bone position. Efficient implant decontamination also appears important but no single method has been shown to be superior to others.[148] Moreover, recent evidence suggests that a thorough understanding of a patient's overall systemic health is important to identify those patients at higher risk for developing peri-implantitis. In relation to a diagnosis of peri-implantitis, a high likelihood of comorbidity was expressed by a history of periodontitis and a history of cardiovascular disease. The odds ratio was 8.7 for cardiovascular disease and 4.5 for periodontitis.[149]

The need for attached gingiva to maintain health is controversial for teeth as well as implants. There appears to be enough evidence to support the benefit of keratinized mucosa around implants despite the scientific controversy. There is substantial evidence to suggest that in the presence of excellent plaque control and regular maintenance, the presence of keratinized gingiva and mucosa around teeth and implants, respectively, is not required. The clinical reality, however, is that most patients do not exhibit excellent home care or follow routine maintenance schedules. Therefore, mucogingival procedures that enhance the quantity as well as quality of the peri-implant tissues should be considered in deficient clinical situations to reduce the risk of implant recession and peri-implantitis development, as well as to improve oral hygiene, phonetics and esthetics.

Conclusion

The advent of dental implants is one of the most significant developments in dentistry this century. However, the decision to replace a tooth with an implant should not be made hastily. Biologic complications around dental implants do occur, and treatment is as of yet not as well studied, understood or as predictable as with similar complications associated with teeth. Further controlled clinical trials on managing biologic implant complications, including peri-implantitis, are needed. Development of improved implant designs, including surgical and prosthetic protocols, may prevent these types of complications in the future. ■

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Treatment Planning Decisions: Implant Placement Versus Preserving Natural Teeth

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ABSTRACT Dental implants are routinely used as a treatment modality for replacing missing teeth. An assessment of whether to extract teeth and place implants or preserve natural dentition can be a complex decision-making process. The purpose of this article is to review some of the factors that influence prosthetic planning of functional and esthetic rehabilitation for patients with diseased dentition either with conventional treatment options or with extractions and replacement with implant-supported prosthesis.

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One of the most important advances in clinical dentistry is the advent of osseointegrated dental implants, which was inspired by the work of Brånemark et al.[1,2] During the past four decades, dental implants have evolved to the point that they are now considered a routine and reliable method of replacing teeth for completely or partially edentulous patients.[1-4] Today, implant-supported or assisted prostheses are often chosen as the treatment of choice when missing teeth are to be replaced. This paradigm shift in treatment planning can be seen as a positive shift as the survival of implant-supported restorations together with the reduced impact to the oral ecology as compared to conventional tooth-supported restorations warrant this direction. However, when teeth remain and a decision to extract teeth is made as part of a restorative treatment plan to accommodate use of dental implants, a careful determination must take place as part of the treatment-planning process. Though diseased, teeth might be maintained with traditional treatment modalities such as periodontal, endodontic and/or restorative therapies. In a traditional dental practice, the extraction of teeth has generally been considered a last resort, largely because of the support required for fixed partial dentures or removable prostheses.[4-6] However, advances in implant dentistry have challenged this school of thought and on occasion replacements of natural teeth with dental implant-supported restorations have been considered equal to or even superior to natural teeth with respect to survival.[7,8] With the information available today, if a risk/benefit analysis is applied to each treatment decision solely based on

survival rates, some maintainable teeth may be extracted.[3-6] This can lead to the central principle in conventional dental practice of tooth preservation being cast aside. It is worth emphasizing that although implants are a treatment for tooth loss and not a substitute for teeth, several factors may sway the decision to replace existing teeth with dental implant prostheses.

In this decision-making process, one important consideration is that implants are not immune to diseases.[6-8] Therefore, replacement of teeth with implants requires a critical assessment of etiological, contributing and prognostic factors along with an in-depth assessment of risk benefits and cost benefit factors. The issue of replacement of teeth with dental implants or treatment of a compromised tooth is one of the most complex decisions that a dentist must make during everyday clinical practice. Hence, the focus of this article is to review some of the factors that influence prosthetic planning when rehabilitating a patient with diseased dentition, specifically concerning whether to utilize conventional endodontic, periodontal and prosthodontic options or extractions and replacement with an implant-supported prosthesis.

Implants Versus Endodontic Therapy

Preserving teeth after endodontic treatment may necessitate additional therapy to modify the periodontium (e.g., crown lengthening) and/or prosthetic procedures (e.g., post and core, core buildup or a crown).[9,10] Each of these procedures will increase the complexity and cost of the treatment. The reduction in periodontal support and tooth structure adversely affects the tooth prognosis. Additionally, when caries is the etiological factor for endodontic lesions, the retained tooth is still vulnerable to the same disease process after endodontic therapy. This may drive treatment-planning decisions toward implant usage. However, it has to be considered that implant dentistry also has its own challenges, including the need for soft and hard tissue site development procedures such as connective tissue grafting, bone grafting and sinus elevation.

The amount of remaining tooth structure is a primary factor that will drive the treatment plan for tooth retention or removal.[11,12] For instance, in the absence of at least 1.5 mm of ferrule, the survival of the restoration and tooth is compromised.[11-13] Furthermore, studies have shown that the risk of endodontic failure is higher in the presence of certain conditions, including chronic periapical infections, a history of unsuccessful endodontic therapy, multiple roots and coexisting periodontal disease; in the face of such risk factors, implant placement might be the treatment of choice over endodontic therapy.[14,15] A history of unsuccessful endodontic re-treatment is most often associated with poor outcomes, suggesting a treatment plan including extraction and implant placement.[16] On the other hand, several studies have reported very high survival rates of teeth that have undergone endodontic treatment, with more than 95 percent of treated teeth remaining functional over time.[16-18] Other studies have demonstrated five-year and 10-year survival rates up to 95 percent and 90 percent, respectively.[19] However, it is important to note that studies reporting high endodontic survival rates are mainly associated with initial endodontic therapy where the integrity of internal and external structures of the teeth is less compromised. Additionally, it should be considered that endodontic therapy by itself needs to be judged based on resolution of the lesion and the published data does not always distinguish between success rates of endodontic therapy with or without prior lesions. Also, the criteria used to define success of endodontic therapy, such as resolution of lesions and/or symptoms, may or may not be relevant in the context of restorative treatment planning. In many circumstances, the decision whether to retain teeth hinges on their position, with anterior teeth being more frequently maintained because of esthetic considerations and reduced forces whereas posterior teeth are more often removed because of functional demands and root complexity.

When caries is the etiological factor for endodontic lesions, the retained tooth is still vulnerable to the same disease process after endodontic therapy.

In conclusion, based on the current evidence available, justification for extraction of teeth with "good" or "fair" initial endodontic prognosis has to be heavily weighted as a prognostic criterion. However, clinical decision making for heavily damaged teeth and teeth requiring re-treatment with advanced loss of tooth structure, recurrent caries, recurrent endodontic lesions and/or high caries risk is swayed toward implant replacement.

Implants Versus Periodontal Therapy

It is well known that after undergoing properly executed treatment, natural teeth with healthy but markedly reduced periodontal support can be maintained and are also capable of carrying an extensive fixed prosthesis for a very long time, with survival rates of about 90 percent provided there is an adequate

follow-up and aftercare program.[20-22] On the other hand, some authors have investigated a current assumption in dental communities that the longevity of implant therapy is superior to that of periodontally compromised teeth.[22-24] This assumption may lead to the extraction of many teeth with periodontal disease that may have a good prognosis after corrective periodontal treatment and control of inflammation. Occasionally, early extraction is justified by the desire to maintain the bone level for implant placement. However, contrary to this assumption, studies have shown that the clinician should not extract teeth with a good or even fair prognosis, as there is no evidence to support an aggressive approach to tooth extraction in order to preserve bone for later implant surgery.[25-27] Periodontal therapies are effective in arresting disease progression; they minimize and prevent periodontal disease-related tooth loss even in advanced cases.[29-31] In addition, 10-year follow-up studies have shown that dental implants do not surpass the longevity of natural teeth, even periodontally compromised ones. This fact is specifically true for well-maintained patients.[28] These contradictory data can lead to confusion when evaluating the evidence in the literature. One must consider whether the reported evidence of successful periodontal therapy comes from dentitions that have to be reconstructed or from patients with periodontitis without the need for reconstruction. A differentiation must be made between maintaining teeth without the requirement for reconstruction of tooth structure as compared to situations where there is a need for substantial biological and financial investment to restore a compromised dentition. This underscores the intricacies of treatment planning in light of evidence-based decision making.

Additionally, factors such as age, bone type/quality/volume and history of periodontitis have been shown to have significant effects on the biological complications after implant therapy.[32] In other words, extraction of periodontitis-affected teeth does not resolve or eliminate the underlying host response-related problems that may have contributed to the development of periodontal disease and which may be predisposing factors for the development of peri-implant diseases which can lead to peri-implant bone loss.[33]

There is no long-term evidence that regenerative treatment has any beneficial outcome around implants with peri-implant bone loss.

When deciding between the maintenance and replacement of teeth affected by periodontitis, it may be important to consider our ability to understand and treat possible future peri-implant diseases. There are histopathological differences between periodontitis and peri-implantitis lesions. These differences relate to the basic difference between the anchorage mechanism of teeth and that of dental implants. Teeth anchor through periodontal ligament and connective tissue attachment whereas dental implants anchor through a titanium oxide layer. In contrast to natural teeth, there is no supracrestal attachment present around implant components. Therefore, the apical extension of inflammatory cell infiltration is more pronounced in peri-implantitis and seen closer to the level of the bone whereas in periodontitis it is located in the apical region of pocket epithelium and in the overlaying connective tissue attachment. Although plasma cells and lymphocytes are dominant in both lesions, in peri-implantitis, neutrophil granulocytes and macrophages occur in larger proportions.[34] Furthermore, in experimental studies of peri-implantitis and periodontitis, upon removal of disease-inducing ligatures there is a self-limiting process around teeth as connective tissue separates the inflammatory cells from the bone. In implants however, the infiltration extends to the bone, where spontaneous progression of the disease occurs even after ligature removal. This spontaneous bone loss seems more pronounced around rough implant surfaces compared to machined implant surfaces.[35]

Because patients with a history of periodontitis seem to be at a higher risk for peri-implant disease, one needs to consider the efficacy of "peri-implantitis" treatment regimes compared to that of treatments for periodontitis while deciding between retaining teeth or replacing them. It has been reported that 92 percent of teeth initially given a poor prognosis were maintained for a five-year period after periodontal regenerative therapy and that 85 percent did not present any further biological complications.[36] In contrast, there is no long-term evidence that regenerative treatment has any beneficial outcome around implants with peri-implant bone loss. In periodontal diseased sites when inflammation cannot be controlled and deeper pockets remain, there is periodontal bone loss and progression of disease, whereas treatment resulting in control of inflammation and reduction of pocket depths will lead to bone and attachment gain.[37] However, there is a lack of data demonstrating

similarly favorable outcomes for cases of peri-implantitis. In experimental models, once the inflammation is under control, treatment of peri-implantitis failed to provide reintegration of previously diseased implant surfaces. However, pristine implants never exposed to peri-implantitis and placed into bony defects caused by peri-implantitis did show osseointegration.[38,39] This study argues for removal of implants with a history of peri-implantitis and replacement with new implants.

These observations underscore the repair and regenerative potential of the periodontium due to the presence of periodontal ligament, in contrast to the limitations of dental implants with respect to repair and reintegration after exposure to disease.

Additionally, with respect to resective periodontal therapy, treatment of teeth will provide a predictable long-term outcome, namely maintenance of health and reduction in need for re-treatment.[40] A study by Romeo reported that resective therapy associated with modification and removal of threads improved pocket depth and mucosal inflammation and seemed to positively influence the survival of oral implants affected by inflammatory processes.[40,41] However, the mixed results in the literature indicate that resective or regenerative therapies for treatment of peri-implant diseases have little long-term success and often involve esthetic compromise.[42]

It has been reported that peri-implantitis affects 16-28 percent of implants after five to 10 years, with higher prevalence among patients with multiple implants.[42] One long-term study showed that up to 60 percent of dental implants were diagnosed with biological complications within eight years after surgical placement.[42,43] Moreover, additional peri-implantitis risk factors such as smoking and poor oral hygiene have been identified and documented. Hence, implant therapy in a patient with a history of periodontitis requires a strict schedule of follow-up and maintenance visits.[43,44]

In comparison, there is a vast body of information supporting the efficacy of periodontal therapy to maintain dental health and function. Such information is not available for peri-implant disease. These data underscore the value of teeth as biological entities and prompt caution in the decision-making process when treating patients with periodontitis.

Implant therapy in a patient with a history of periodontitis requires a strict schedule of follow-up and maintenance visits.

However, once again it should be emphasized that the decision to maintain teeth with periodontal disease is not solely dependent on the expected outcome of periodontal therapy. As health care practitioners, we are treating patients, not only teeth. When significant biological and financial investments are to be made, the risk/benefit and cost/benefit analysis of different treatment modalities should be considered. Functional and esthetic demands of a particular patient may influence the treatment decision despite the periodontal prognosis. For example, treatment of a patient with localized periodontal disease, intact dentition and limited or no restorative needs would primarily hinge upon the outcome of periodontal therapy. As another example, treatment of a patient with generalized aggressive periodontitis or severe chronic periodontitis without functional mobility would again hinge upon the outcome of periodontal therapy. However, another patient with the same periodontal diagnosis who exhibits restorative needs ranging from functional mobility, esthetic demands, severe occlusal wear, advanced caries or malocclusion may be better served with implant reconstruction, considering the risk/benefit and cost/benefit analyses. Therefore, it could be argued that when the primary dental disease is periodontitis without major restorative treatment needs, the potential for successful periodontal treatment should not be discounted, and the decision to replace the teeth should be heavily judged. However, if the teeth have severely weakened structure because of previous restorative therapy, caries, root canal therapy or wear, the clinical decision may be swayed toward replacement with dental implants.

Implants Versus Conventional Prosthodontic Treatments

From a prosthodontic point of view, various technical complications can occur with tooth-supported fixed partial dentures (FPDs). These complications include recurrent caries, loss of the abutment tooth/teeth or abutment tooth fracture.[45,46] For instance, tooth reduction weakens the tooth, hastening its failure. Furthermore, because of casting discrepancies, the fit of long-span fixed partial dentures is less than perfect, contributing to recurrent caries and failures. Frequently splinted units compromise oral hygiene access; therefore, with this type of prosthetic design, a strict and frequent maintenance program is of the utmost importance.[47]

Another clinical dilemma for a restorative dentist is the decision to keep or extract a diseased tooth based on soft tissue esthetic demands. There are several important factors that the restorative

dentist should therefore consider prior to deciding whether to extract and place an implant or to keep the tooth primarily to address esthetic demands. The patient's expectations, smile line, gingival biotype and local bone availability are especially important and should be accurately considered and analyzed.[48,49]

In the esthetic zone, the risk of recession after surgical placement of an implant should be analyzed via gingival biotype assessment. It is generally accepted that the biotype will partly determine the amount of postsurgical recession. A thin biotype with highly scalloped architecture is much more prone to postimplant placement recession in comparison to a thick gingival biotype with flat architecture.[50] Implant position in these clinical circumstances will also play a role as a risk factor for gingival recession. When presented with a thin scalloped biotype, more consideration has to be given to retention of the tooth to prevent the possibility of soft tissue complications. It is recommended that in the anterior esthetic zone, the clinician should strongly consider keeping the natural dentition as soft tissue contours can be more predictably established due to the attachment apparatus of the periodontium, while for posterior segments implants are recommended as usually function is the prevailing requirement. In clinical situations presenting with attachment loss where the esthetics is of utmost importance, pink porcelain can be utilized after corrective bone resective surgical procedures.

In summary, the restorative decision making of diseased teeth depends on several factors such as the amount of remaining tooth structure, the region of the mouth being treated, the patient specific anatomical presentation, functional and aesthetic demands, periodontal and endodontic prognosis, risk /benefits, and cost/benefits factors. Considerations of all these factors underscore the challenge of treatment planning in balancing evidence-based knowledge with patient-specific parameters that are subjective in nature. A thorough understanding of patient-specific parameters and clear communication with the patient and amongst specialty care providers is essential to make difficult decisions to replace or maintain diseased teeth in the context of comprehensive patient care.

The patient's expectations, smile line, gingival biotype and local bone availability are especially important and should be accurately considered and analyzed.

Clinical Patient Treatment Presentation

In the following two clinical cases, presentation and comprehensive treatment planning will be discussed to illustrate how it is possible to achieve favorable outcomes and deliver long-lasting restorations that provide both functional and esthetic outcomes for patients.

Patient One Treatment

This is the case of a 64-year-old Caucasian male patient. The patient reported that he had lost his teeth because of fracture and recurrent caries. Upon examination, the patient was found to have worn and supraerupted mandibular anterior teeth (**FIGURES 1** and **2**) with active wear characteristics. A number of factors were taken into consideration in order to decide whether to preserve the remaining dentition in the mandible or to extract and restore with implant-supported prostheses. It was concluded that in order to maintain all the remaining mandibular teeth, either root canal therapy (RCT) or re-treatment of previous RCT was necessary, in addition to the need for crown lengthening surgeries and traditional post-core and crown procedures. Based on our comprehensive data collection, risk analysis and cost/benefit assessment, it was decided to extract all the remaining mandibular teeth and replace them with implant-supported restorations. In addition, the left maxillary central incisor presented with a history of root canal therapy and apicoectomy (**FIGURE 3**). However, as is apparent in **FIGURE 3**, a radiolucent lesion was still present in the pre-apical region. Considering the main reasons of tooth loss in this patient (parafunctional habits and recurrent caries), our risk and cost/benefit analyses led us to decide to extract the left central incisor and place an implant as an alternative to endodontic re-treatment followed by post-core and crown procedures (**FIGURE 4**). In this case, implant- and tooth-supported PFM restorations were delivered in the maxilla and mandible (**FIGURES 5–7**). These restorations used metal for the posterior occluding surfaces at an increased vertical dimension of occlusion (VDO), providing acceptable esthetics and function. It should be emphasized that the patient should be under strict prosthodontic and periodontal recall programs.

Patient Two Treatment

A 59-year old Caucasian patient presented with loss of tooth structure because of parafunctional habits (**FIGURE 8**). Moreover, severe tooth discoloration was one of the patient's chief complaints (**FIGURE 9**). After performing initial data

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PATIENT 1

FIGURE 1A.

FIGURES 1A and **B.** Panoramic and full-mouth radiographic examination of Patient 1 upon presentation.

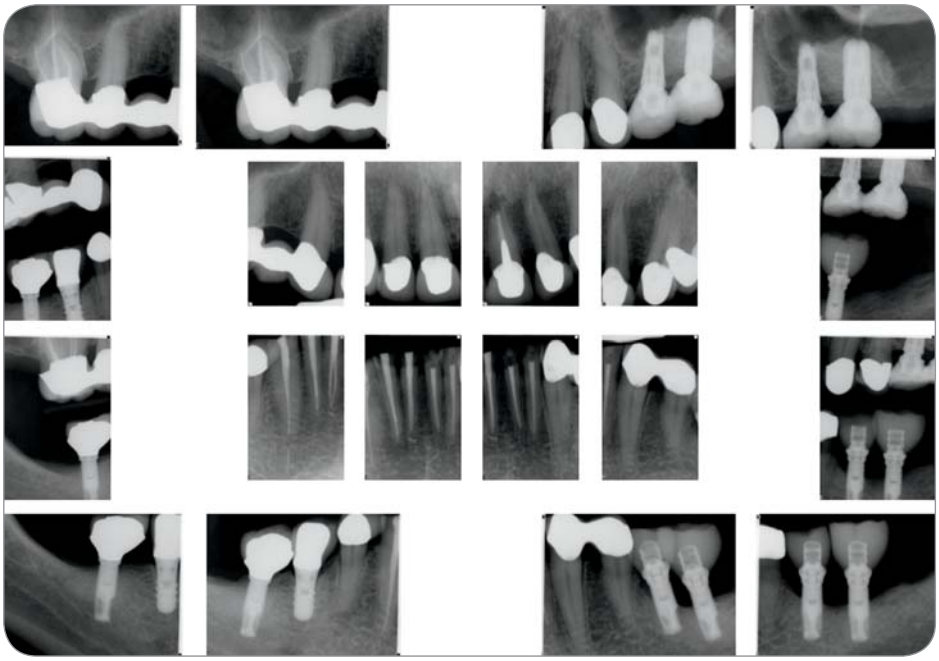

FIGURE 1B.

FIGURE 2A.

FIGURE 2B.

FIGURE 2C.

FIGURES 2A–C. Intraoral view (frontal and lateral) of Patient 1 upon presentation, pretreatment.

FIGURE 3. Periapical radiograph of Patient 1, left maxillary central incisor showing a short post and presence of radiolucency in the periapical region.

FIGURE 4A.

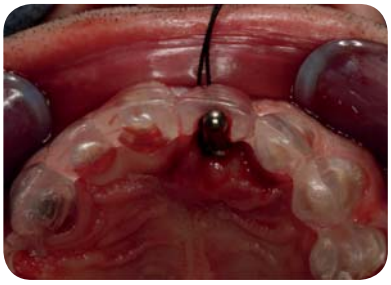

FIGURE 4B.

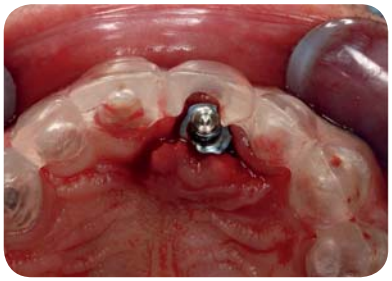

FIGURE 4C.

FIGURE 4D.

FIGURES 4A–D. The left central incisor of Patient 1 was extracted and an implant was immediately placed.

FIGURE 5A.

FIGURE 5B.

FIGURE 5C.

FIGURES 5A–C. Intraoral view of the definitive restorations showing the corrected occlusal plane while maintaining the esthetics of the maxillary anterior sextant.

FIGURE 6A.

FIGURE 6B.

FIGURE 6C.

FIGURES 6A–C. Extraoral views of definitive tooth- and implant-supported restorations with satisfactory esthetic and functional outcomes.

FIGURE 7A.

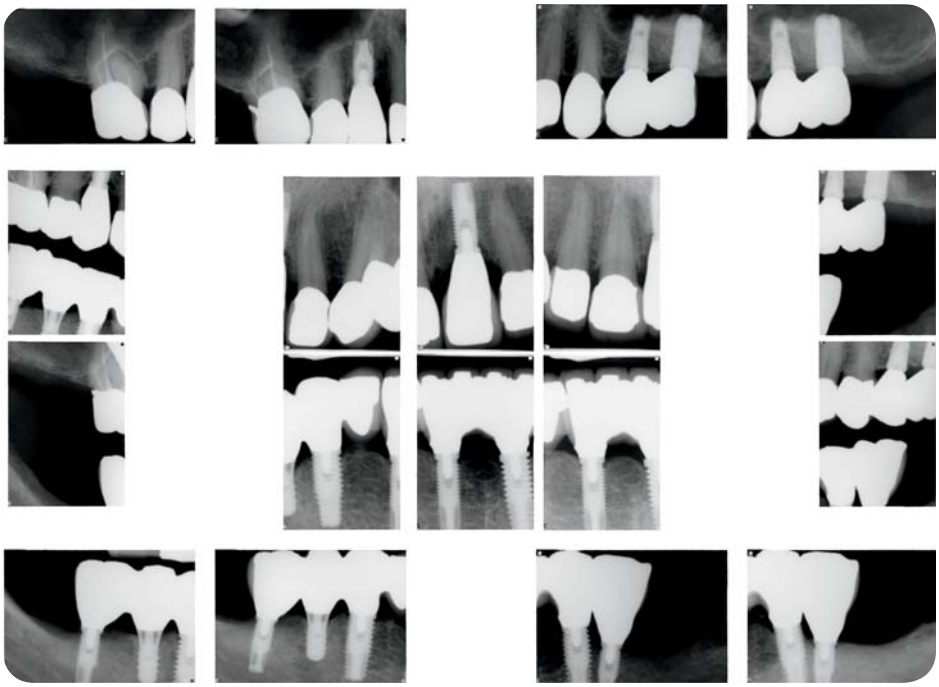

FIGURE 7B.

FIGURES 7A and **B.** Panoramic and full-mouth radiographic appearance of Patient 1 with full-mouth rehabilitation after delivery.

PATIENT 2

FIGURE 8A.

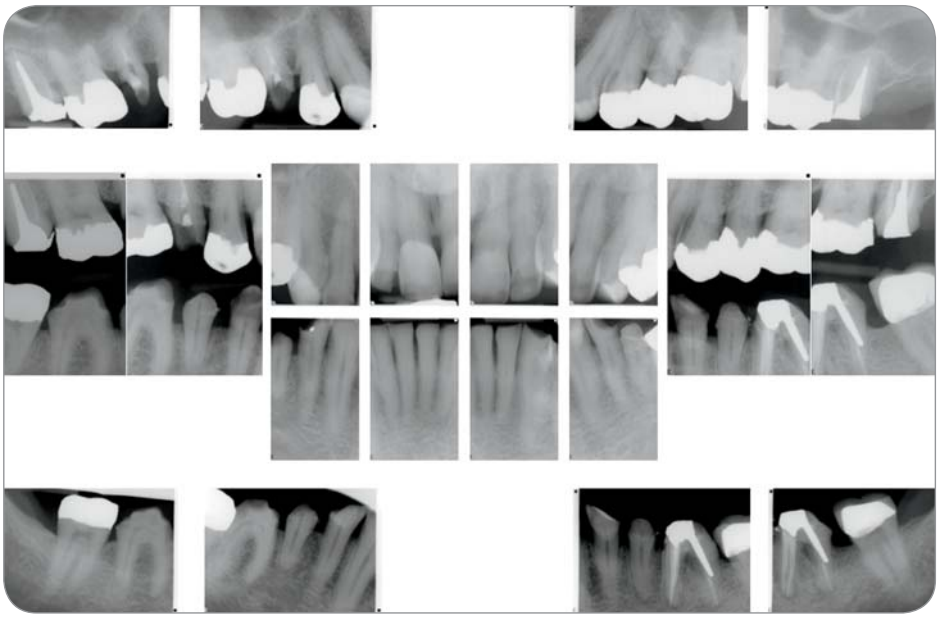

FIGURE 8B.

FIGURES 8A and **B.** Panoramic and full mouth radiographic appearance of Patient 2 upon presentation.

FIGURE 9A.

FIGURE 9B.

FIGURE 9C.

FIGURES 9A–C. Extraoral frontal view of Patient 2 upon presentation, demonstrating loss of tooth structure due to para-functional habits and presence of severe discoloration.

FIGURE 10. Periapical radiograph of the second maxillary bicuspid on the right side (No. 4) showing a very short root with unfavorable crown-to-root ratio. In addition, keeping this tooth would require RCT re-treatment, and a post and crown with questionable prognosis and predictability.

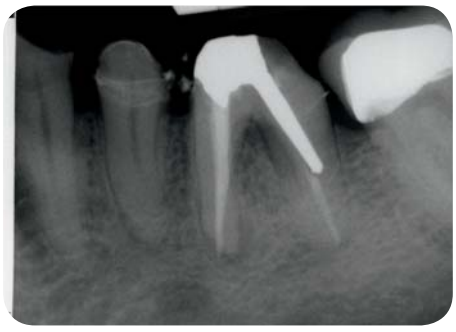

FIGURE 11. Periapical radiograph of the left first mandibular molar. Note the thin remaining dentin walls in both roots and presence of radiolucency around the furcation area.

FIGURE 12A.

FIGURE 12B.

FIGURE 12C.

FIGURES 12A–C. Intra- and extraoral views of definitive tooth and implant supported restorations with satisfactory esthetic and functional outcomes in Patient 2.

FIGURE 13A.

FIGURES 13A and **B.** Panoramic and full-mouth radiographic appearance of Patient 2 with full-mouth rehabilitation after delivery.

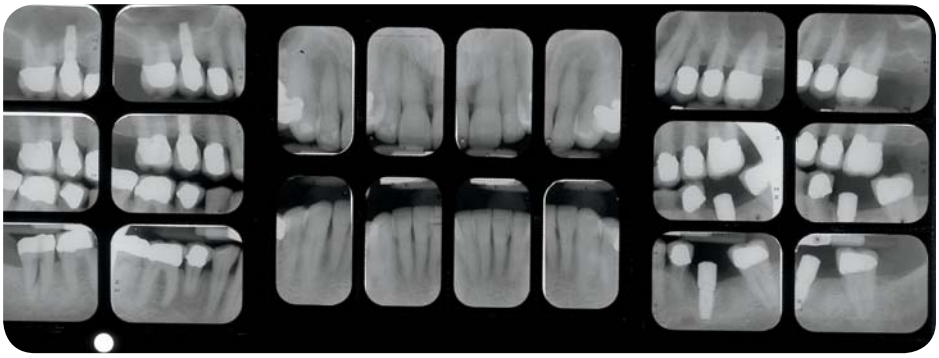

FIGURE 13B.

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collection as well as risk and cost/benefit assessment, it was decided to maintain all teeth in the maxilla and mandible, and restore them with either bonded all-ceramic or PFM restorations. However, after further analysis of the second maxillary bicuspid on the right side (No. 4) (**FIGURE 10**) and the first mandibular molar on the left side (No. 19) (**FIGURE 11**) it was revealed that keeping these two teeth would necessitate re-treatment of their RCTs, postspace preparation and fabrication of post-cores, leaving weakened tooth structure to support a full-coverage restoration. Additionally, the presence of radiolucency in the furcation area of No. 19 could be associated with root canal perforation and/or tooth fracture. It was also noted that No. 4 had a very short root, and the presence of class III mobility in both of these teeth further dimmed the prognosis. Because of a questionable prognosis for teeth Nos. 4 and 19, it was decided to extract and replace them with dental implant-supported restorations. Therefore, the final treatment plan consisted of delivery of implants, tooth-supported PFM and all-ceramic restorations in the maxilla and mandible (**FIGURES 12** and **13**).

Summary

A common clinical dilemma in modern dentistry is the decision whether to extract a tooth and place an implant or keep the natural tooth. There is no definitive answer in this debate, as each of these treatment options has its advantages and disadvantages. Clinicians should always remind themselves that implants can be functional and esthetic replacements for missing teeth, but carry their own risks and are unsuitable in many situations; they should not be considered an easy alternative to treating salvageable teeth. In order to achieve the ideal treatment plan, one should always consider and address the patient's chief complaint. Proper cost-benefit and risk assessment analysis should be performed prior to treatment. The patient's oral hygiene, history of smoking and history of periodontal disease are among the important factors that need to be considered in the treatment-planning process. Altogether, in order to achieve optimal results, the restorative dentist must always perform a comprehensive risk/benefit and cost/benefit assessment in order to deliver long-lasting restorations with acceptable esthetic and functional outcomes. ■

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Email in the Age of Privacy

TDIC Risk Management Staff

The ongoing discussion about patient privacy leads to numerous questions. The Dentists Insurance Company (TDIC) reports increased inquiries on its Advice Line about patient privacy and email communication from policyholders regarding patients and other providers.

HIPAA and state laws protect patient privacy and require dentists to take precautions to ensure that a patient's private health information is not compromised. Such precautions include:

- Making sure to use reasonable safeguards such as limiting the amount of information sent via email, checking the email address for accuracy before sending and sending an initial email to the patient to confirm the address before transmitting dental records or treatment information.
- Sending email securely, which can be achieved a number of ways, including encryption, secure file transfer software or proprietary information sharing websites.
- Informing the patient that unsecured emails have risks and securing patient authorization in writing before sending email that are not encrypted.
- Training staff on proper email use to meet security standards.
- Performing a written risk assessment to reveal where a practice's protected health information could be at risk. Include email procedures in the assessment.

"When it comes to email security, the focus tends to be on encryption, and whether it is required," said Teresa Pichay, a regulatory policy analyst with the California Dental Association. "HIPAA requires electronic communication of patient information to be secure, and encryption is just one way of doing that. However, it is not specifically required that email be encrypted." Pichay said other security measures such as virtual private networks (VPNs) that are password protected and other "reasonable safeguards" are acceptable for email communications.

> "HIPAA requires electronic communication of patient information to be secure, and encryption is just one way of doing that."
>
> THERESA PICHAY

According to the U.S. Department of Health and Human Services website, the HIPAA Privacy Rule does not prohibit the use of unencrypted email for treatment-related communications between providers and patients, but states, "Other safeguards should be applied to reasonably protect privacy, such as limiting the amount or type of information disclosed through the unencrypted email."

"Limiting the amount of information is a key point," Pichay said. "Send only the minimum necessary information in email."

Pichay emphasized that dentists must not send information to a patient through unencrypted email unless the patient is advised about the risks associated with unsecured email. Such risks include possible disclosure or interception of "identifiable health information" by unauthorized third parties. Dentists must receive patient consent to receive unencrypted email and retain documentation with the patient record. An authorization form for patient consent to receive unencrypted email must be a standalone document, according to the American Dental Association, which provides a sample form on its website at ada.org.

However, if the use of unencrypted email is unacceptable to a patient who requests confidential communication, other ways of sending dental information, such as by regular mail, should be offered. Also, patient consent to receive unencrypted email is not consent to send patient health information in nonsecured emails with other parties such as specialists and payers. As mentioned previously, electronic communication can be sent securely a number of ways including encryption, secure file transfer software or proprietary information sharing websites.

In addition to HIPAA, state laws also apply to patient privacy. In California, AB 211, passed in 2008, imposes penalties upon individuals and institutions that

fail to protect the privacy of patient medical records. The law called for the creation of the enforcement agency known as the Office of Health Information Integrity (CalOHII). Penalties imposed by AB 211 vary depending upon the circumstances of the violation, but can reach a maximum of $250,000 if the patient suffers economic loss or personal injury. Additionally, CalOHII may notify the Dental Board of California for further investigation or discipline of individual providers. Laws vary by state and further information is available on state Department of Health websites.

If a dental practice is scrutinized by a regulatory agency, a risk assessment and policies and procedures pertaining to electronic security can help a dental practice demonstrate compliance with HIPAA. Include email communication as part of a dental practice's risk assessment that takes into account all of the office's electronic patient information including electronic dental records and digital radiographs. HHS recently released a security risk assessment tool to assist with HIPAA compliance for all states. The application is available for download at HealthIT.gov/security-risk-assessment and produces a report that can be provided to auditors.

Dentists must also train their office staff on proper email use. For example, consider giving the patient a heads-up phone call letting him or her know an email is on its way prior to sending protected health information, or communicating a decryption password or code separately from the encrypted email. ■

TDIC's Risk Management Advice Line at 800.733.0634 connects dentists to trained analysts who can answer questions about email communication or other dental practice issues.

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Kerri McCullough
LIC #01382259
(949) 566-3056
35 Years in Business

Mario Molina
LIC #01423762
(949) 675-5578
35 Years in Business

Jaci Hardison
LIC #01927713
(949) 675-5578
26 Years in Business

Steve Caudill
LIC #00411157
(951) 314-5542
25 Years in Business

Thinh Tran
LIC #01863784
(949) 675-5578
11 Years in Business

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ANAHEIM: NEW LISTING! General Dentistry Practice & Bldg. 6 Ops, 2 Equipped, 4 Plumbed. Near Disneyland. Established 39 Years. #CA186

BAKERSFIELD: NEW LISTING! General Dentistry Practice. 4 Ops. Pano. Established 20+ Years. 2013 GR $521K. #CA193

BALDWIN PARK: General Dentistry Practice. 5 Ops, 4 Equipped. 2013 GR $286K w/Adj Net $133K. Dr is moving out of state. #CA176

BANNING: General Dentistry Practice. 6 Ops w/Room for Expansion. Paperless, Digital, EagleSoft. 8 Days Hygiene/Week. 2013 GR $1.5MM+. #CA183

BAY AREA: Periodontal Practice.2120 SF. 6 Ops. Digital X-rays, Pulse Oximeter, Endoscope, Piezosurgery, Dentrix. #CA167

CHULA VISTA: General Dentistry Practice. 4 Ops. Dentrix Software. 3½ Days Hygiene. 2012 GR $528K. #CA109

EASTERN SIERRAS: General Dentistry Practice. 1650 SF. 4 Ops. Low 52% Overhead. 2012 GR $521K. #CA528.

FREMONT: General Dentistry Practice. 3000 SF. 10 Ops. Digital X-rays, Pan. 4000 Active Patients. PPO/HMO, 2012 GR $1.2MM w/Adj Net $300K. #CA553—IN ESCROW!

FRESNO: General Dentistry Partnership. ~7500 Active Patients. 2013 Partnership GR $4.708M. Selling Partner 2013 Net Income $368K. #CA192

FRESNO: General Dentistry Practice. 2000 SF. 5 Ops. 5 Days Hygiene. 23 New Patients/ Month. 2013 GR $789K. Practice Started in 1997. #CA171—IN ESCROW!

GREATER LINCOLN/ROSEVILLE: General Dentistry Practice. 2150 SF. 3 Ops, 2 Add'l Plumbed. Intraoral, Digital X-ray, Laser, Eaglesoft. 2013 GR $528K+. #CA165

GREATER LOS ANGELES: Perio Practice. 5 Ops, 34 Years Goodwill. Call for More Information. #CA173

GREATER ROSEVILLE/ROCKLIN/ LINCOLN: General Dentistry Practice. 1887 SF. 2 Ops, 3 Add'l Plubmed. 3 Days Hygiene. Eaglesoft. 2013 GR $350K+. #CA154—IN ESCROW!

GREATER SACRAMENTO: PRICE REDUCED $50K! General Dentistry Practice & Condo. 1300 SF. 4 Ops. Prof. Bldg. Eaglesoft. 2013 GR $679K. #CA138

GREATER SACRAMENTO: General Dentistry Practice. 3079 SF. 7 Ops. Office Shared w/2nd DDS—Separate Practices. Digital X-ray, Pano, Datacon. 2013 GR $974K. #CA140

GREATER SACRAMENTO: General Dentistry Practice. 1600 SF. 5 Ops, 1 Add'l Plumbed. Eaglesoft, E4D, Intra-Oral, Pano. 9 Days Hygiene. 2012 Fiscal Year GR $888K+. #CA156—IN ESCROW!

HAWAII (MAUI): General Dentistry Practice. ~1200SF. 4 Ops. GR $636K. #20101

HUNTINGTON BEACH: General Dentistry Practice. 6 Ops, 3 Equipped, 3 Plumbed. Established 18 Years. #CA155—IN ESCROW!

HUNTINGTON BEACH: NEW LISTING! General Dentistry Practice. 3 Ops. Dentrix, Digital X-rays. Laser, Intraoral Camera. Established 23 Years. #CA194

INDIAN WELLS: General Dentistry/TMJ Practice. 4000 SF. 6 Ops. 2011 GR $350K+ on 1 DDS Day/Week. #CAM530

LA MESA: General Dentistry Practice. 2000 SF. 3 Ops. Prof. Bldg. Dentrix, Laser, Digital X-rays. 2012 GR $396K w/Adj Net $155K. #CA127

LOMA LINDA: NEW LISTING! General Dentistry Practice. 4 Ops. Intra-oral Camera, Digital X-rays, Pano. 2013 GR $631K. #CA185

MENDOCINO COAST: General Dentistry Practice. 2376 SF. 4 Ops. Dentrix, Intraoral Camera, CAD/CAM. 2013 GR $1.025M. #CA181

MILPITAS: General Dentistry Practice. 1650 SF. 5 Equipped Ops. Pano, Intra-oral, Laser. 7 Days Hygiene/Week. 2013 GR $935K, Owner retiring. #CA180—IN ESCROW!

MURRIETA: General Dentistry Practice. 7 Ops. CEREC, Dentrix. 2013 GR $1.4MM+ w/Adj Net $521K. #CA163—IN ESCROW!

NEWPORT BEACH: PRICE REDUCED! General Dentistry Practice. 3 Ops. Newer, High-End Equipment. 2012 GR $350K on 3½ Days/Week. #CAM534

NORTH EAST BAY: PRICE REDUCED **$77K!** General Dentistry Practice. 2324 SF. 7 Ops. Dental Mate, Intraoral Camera, Pano X-ray, Digital X-ray. 2012 GR $885K. Bldg to Be Sold w/Practice. #CA108—IN ESCROW!

NORTH HOLLYWOOD: NEW LISTING! General Dentistry Practice. 6 Ops, 5 Equipped, 1 Plumbed. Dentrix, Digital X-rays, Pano, Laser, Paperless. 2013 GR $845K. #CA187

NORTH OF SACRAMENTO: General Dentistry Practice. 2050 SF. 5 Ops. Dentrix, Intra-oral Cameras, Digital X-ray, Imaging System, Pano. 2012 GR $1.2M+. #CA106—IN ESCROW!

NORTH ORANGE COUNTY: NEW LISTING! General Dentistry Practice. 2700 SF. 7 Ops, 6 Equipped. GR $601K w/Adj Net $244K on 3 Days/Week. #CA189

NORTH ORANGE COUNTY: NEW LISTING! Ortho Office. Leasehold Improvements Plus some Patients. 4 Chairs in Open Bay in Busy Retail Center. Upscale Family Community. #CA188

NORTHERN CALIFORNIA: Periodontal Practice. Partnership Position. 1500 SF. 6 Ops. Dentrix. Owner Financing Available. #CA168

NORTHERN CALIFORNIA: Endodontic Practice. 1200 SF. 3 Ops, 1 Add'l Plumbed. Two Microscopes, Digital. 2013 GR $319,865. #CA158—IN ESCROW!

NORTHERN CALIFORNIA: Endodontic Practice. 1021 SF. 4 Equipped Ops, 1 Add'l Available. Dentrix. 2013 GR $337K. Owner Retiring. #CA169

ORANGE COUNTY: Oral Surgery Practice. 5 Ops. Prof. Bldg. 2013 GR $1.3MM+ w/Adj Net $870K. #CA164—IN ESCROW!

ORANGE COUNTY: Perio Practice. 6 Ops, 5 Equipped. Great Location (Near Hospital, Freeway & Shopping). 2013 GR $479K w/Adj Net $164K. #CA172

PITTSBURG: General Dentistry Practice. 1400 SF. 5 Ops. Pano, Fiber Optics. 12 New Patients/Month. 3 Year Avg GR $236K w/60% Overhead. #CA133

PLUMAS COUNTY: PRICE REDUCED! General Dentistry Practice & Bldg. 4 Equipped Ops, 5 Available. ~1500 Active Patients. EZ Dental, Pan. 2012 GR $515K on 32 Hours/ Week. #CA558

REDLANDS: General Dentistry Practice. 3 Ops. Established 48 Years. GR $364K on 3 DDS Days & 3 Hygiene Days/Week. #CA160

RIDGECREST: General Dentistry Practice & Bldg. 1500+ SF. 4 Ops. 2012 GR $175K. #CA523

SACRAMENTO: General Dentistry Practice. 2400 SF. 7 Equipped Ops, 1 Add'l Plumbed. Intra-Oral, Digital X-ray, Pano, Softdent. 2013 GR $711,014. #CA182

SAN BERNARDINO: General Dentistry Practice. 4 Ops. 30+ Years Goodwill. GR $265K Last 3 Years. DDS retiring. #CA150

SAN DIEGO: General Dentistry Practice. 3 Ops. FFS Practice w/PracticeWorks. Central Area of San Diego. 2014 GR $187K. #CA161

SAN FERNANDO VALLEY: General Dentistry Practice. 3 Ops. Established 30 Years. EagleSoft, Digital X-Rays. 2013 GR $177K. #CA159

SAN FRANCISCO: General Dentistry Practice. 1744 SF. 4 Equipped Ops, 1 Add'l Plumbed. Pano, Digital X-ray, Intra-oral Camera, Softdent. 2013 GR $906K w/Adj Net $338K. #CA162—IN ESCROW!

SAN FRANCISCO: General Dentistry Practice. 780 SF. 3 Ops, 2 Equipped. Near Union Square. 55% Overhead. 2013 GR $854K. #CA191

SAN JOSE: General Dentistry Practice. 1200 SF. 3 Ops. Pano, Eaglesoft. 2013 GR $370K on 30 Hours/Week, 2 Days Hygiene/ Week. #CA178—IN ESCROW!

SAN JOSE: Facility Only. 1400 SF. 7 Ops. Pano, Digital Scanner, 5-Station Computer Network. #CA190

SAN MATEO: General Dentistry Practice. 2150 SF. 5 Plumbed Ops, 4 Equipped. Dentrix, Digital X-ray, Film-based Pano, Intraoral. 2013 GR $708K w/5 Days Hygiene/Week. #CA179

SANTA CRUZ COUNTY: General Dentistry Practice. 1100 SF. 3 Ops. Prof. Bldg. 2200 Active Patients. Digital X-ray, Dentrix. GR $338K on 2 Day/Week. #CA550

SANTA MARIA: General Dentistry Practice. 1500 SF. 4 Ops. Easy Dental, DEXIS, Digital X-ray, Intraoral Cameras. 2013 GR $523K in 180 DDS Days, 5 Days Hygiene. #CA166

SOUTH COUNTY SAN DIEGO: General Dentistry Practice. 1100 SF. 3 Ops. Easy Dental, Digital X-Rays. GR $195K. Great Location, Growth Potential. #CA175

SOUTH ORANGE COUNTY: NEW LISTING! General Dentistry Practice. 5 Ops. EagleSoft, Intraoral Camera. 2013 GR $400K w/Adj Net $136K. #CA192

TEMECULA: General Dentistry Practice. 6 Ops. Established 26 Years. EagleSoft w/14 Workstations, Digital, CEREC, Pano. Well-established Hygiene Program. Dedicated, Long-Term Staff. #CA174

THOUSAND OAKS: FACILITY ONLY! 1325 SF. 4 Ops. Dentrix w/4 Workstations. Equipped Business Office. Sterilization Area. Great Start-up Location, Satellite Office. #CA137

VICTORVILLE: General Dentistry Practice. 2150 SF. 3 Equipped Ops, 3 Add'l Plumbed. Established 34 Years. SoftDent. 2013 GR $313K w/Adj Net $147K. #CA149

WALNUT CREEK: PRICE REDUCED! Prosthodontic Practice. 3 Ops, Full Lab. 2013 GR $399K w/Adj Net $143K. #CAM540

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HIPAA Safeguards

CDA Practice Support

Dentists and their staffs hear prescriptive information about safeguarding patient information, for example, "paper records must be kept in locking file cabinets" and "sign-in sheets cannot be used." Prescriptive information is clearly stated and easy to understand, but is it all really required by HIPAA?

The HIPAA Privacy Rule does not prescribe *any* specific practices or actions (generally referred to as "safeguards"), but the HIPAA Security Rule does. A covered entity should take a flexible approach when considering how to protect patient information. A covered entity needs to consider its particular circumstances, such as impact on patient care, the size of its organization, and the financial and administrative burden of implementing a specific safeguard. A covered entity is not expected to absolutely protect patient health information from all threats and risks, but is expected to implement reasonable safeguards.

The following is an example of a deliberative process to determine what may be reasonable safeguards for paper chart storage in a dental practice. Dr. Gray is a solo practitioner with one front desk staff and one dental assistant. Her practice has been located in a strip mall for the past 15 years. Charts are stored in nonlocking file cabinets located behind the front desk/counter. There is not a lot of extra space in the practice or in the front desk/counter area. The front desk/counter is situated behind a wall with a window and a door to the waiting room. The window is opened when patients check in or when staff communicates with individuals in the waiting room. The door is closed but unlocked during business hours. The area where charts are stored is observed by the dentist or staff during business hours. Both the front door and the door leading to the treatment area are locked when the practice is closed. Does Dr. Gray need to buy locking file cabinets for the charts?

Before answering the question, consider the following:

- What are the risks of not using locking file cabinets and what level of risk is it — low, medium or high?
- Will changing the file cabinets cause minor or major disruption to the practice?
- Is the improved security benefit worth the total cost of the cabinets (installation plus lost production time)?

Also, consider how the analysis changes if Dr. Gray is planning to expand her practice and take over the space next to hers, if the strip mall provides after-hours security or if there is a history of break-ins in the neighborhood. What if one staff member is absent and the front desk/counter is left unattended for a period — what should Dr. Gray do?

When a covered entity decides not to implement a privacy safeguard or addressable security safeguard that offers the best protection, the covered entity should document the rationale for the decision. Determining what safeguards

to implement can be a multifactorial process. HIPAA does not require every dental practice to implement the exact same safeguards adopted by every other dental practice. Some privacy safeguards, such as keeping voices low when speaking about patient health information in places where the information can be overheard, can be universally implemented. Other safeguards, especially the addressable safeguards in the HIPAA Security Rule, can be assessed before determining whether to implement them.

The Security Rule has 19 required safeguards and 16 addressable safeguards. Addressable safeguards should be implemented if a covered entity, after conducting its risk analysis, deems the safeguard reasonable, appropriate and applicable. Some of the addressable safeguards include:

- Implementing procedures to determine that the access of a staff member to patient information is appropriate.
- Implementing procedures for terminating access to patient information when employment of a staff member ends.
- Implementing security reminders.
- Implementing procedures to guard against and detect malicious software.
- Implementing procedures for periodic testing and revision of contingency plans.
- Implementing procedures for creating, changing and safeguarding passwords.
- Establishing procedures that allow access to the physical space where data is stored in support of restoration of lost data under a disaster recovery plan and emergency mode operations plan.
- Implementing policies and procedures to safeguard the physical facility and equipment from unauthorized physical access and theft.
- Implementing policies and procedures to document repairs and modifications to the physical components of a facility that are related to security (for example, walls, doors and locks.
- Implementing a mechanism to encrypt patient information whenever appropriate.
- Implementing policies and procedures to prevent improper alteration of information on the system.
- Implementing mechanisms to verify that patient information has not been altered or destroyed in an unauthorized manner.

Regulatory Compliance appears monthly and features resources about laws and regulations that impact dental practices. Visit cda.org/practicesupport for more than 600 practice support resources, including practice management, employment practices, dental benefit plans and regulatory compliance.

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6072 MODESTO 2014 Collections tracking $450,000. 2013 collections totaled $640,000. When Management devotes attention, practice performs better. Extremely busy Owner seeks New Doc who can devote the attention practice warrants. Digital 5 ops with digital Panorex. Nice blend between PPO & HMO.

6071 CHICO Very strong foundation here. Strength of practice is 4-day Hygiene schedule. Retiring DDS just focuses on restorative aspects with Endo, OS, Perio and Pedo referred. 2014 projects $450,000 in collections. Beautiful 4 op office. Full price $175,000.

6070 VISALIA Extremely attractive community to raise one's family. This opportunity provides that secure vehicle for doing such.
Well established and performing at enviable levels with more room to grow. Averages 12 new patients per month with 1,000 different patients seen last 12-months. Strong Hygiene Department, beautiful facility and well equipped. Digital throughout. Seller available for transition assistance. Not a Delta Premiere practice. This high quality practice has great reputation. Well positioned for the future.

6068 KINGSBURG Great family community 20-minutes south of Fresno. Long established. Owner works relaxed schedule doing restorative dentistry. Endo and OS referred. 2013 collected $293,000 with $154,000 in Profits. 3 ops. Full price $135,000.

6067 MONTEREY - ADVANCED RESTORATIVE PRACTICE Strong foundation for DDS desiring quality restoration practice in mature and affluent demographic. $310,000 invested here. Digital office includes Panorex and paperless charting. 2013 produced $525,000 and collected $458,000. This is an "out-of-network" practice. Seller available to offer considerable transition assistance. Full price $185,000.

6065 SOUTHERN ALAMEDA COUNTY 2014 trending $450,000. 2013 realized Profits of $228,000 on collections of $467,000. Attractive 3 op office with tranquil views of garden setting. Digital radiography includes Panorex.

6064 BERKELEY'S ALTA BATES MEDICAL VILLAGE Strong performer on Owner's 24 hour week. Current year tracking $750,000+. 4-days of Hygiene. Lots of work referred out. Renowned Medical Village has regional draw.

6062 SAN FRANCISCO'S MISSION DISTRICT Ground floor office in Los Portales Medical Building. SF's hi tech work force is moving into The Mission and transforming area. Client moving into purchased building 1.2 miles away. Has been $1 Million/year office. 4 ops fully equipped. Digital. Full price $60,000.

6061 LODI Beautiful digital 5 ops with Panorex and paperless. 16+ years left on Lease. 2-day week shall collect $160,000 in 2014. Will see immediate improvement with Successor who devotes full attention here. $340,000 invested here. Full price $200,000.

6059 MODESTO Coffee Road. 3 ops. Collections have averaged $295,000 with Profits of $155,000+ last two years. Successor shall see pop in New Patients by becoming PPO provider.

ANAHEIM HILLS Group member wanted. Hi identity. GP

ANAHEIM 2 days wk. Hi identity. Grosses $20,000-to-$30,000/month. New digital x-ray. Full Price $225,000.

BAKERSFIELD Lady DDS Grosses $800,000. Great profits. Shopping center. Full Price $585,000.

BAKERSFIELD 1,000's of patients. Low overhead. Can do $1 Million. Beautiful 8-op office. Bargain.

BAKERSFILED AREA Small town. 4-op practice with building. Full price $350,000.

BAKERSFIELD – NORTH Gross $1.5 Million working four 6 hour days. 50% net.

BAKERSFIELD - SOUTH Practice & RE. 1,800 sq.ft. 5 ops and apt. Building renovated June 2014. Full Price $350,000.

HEMET Beautiful 10 ops. Will be $1 Million office. Buy 50% for $300,000.

HMO 2 practices grossing $4.5 Million. $35,000/mth cap checks. Call Tom Fitterer at 714-832-0230.

HUNTINGTON PARK 98% Hispanic. Grosses $600K. Low overhead. 4 ops.

HUNTINGTON PARK Hi identity. 50,000 autos/day. 3 ops. Full Price $195,000.

IRVINE Low overhead. Quality 5 op. Grossing $300,000 – nets 50%. Great Lease. 3 days of Hygiene.

LAKE FOREST 7 ops located across street from major employer.

LONG BEACH Established 40 years. Includes dental condo. Bargain.

NEVADA RESORT AREA Grosses $600,000 on 3 Days. 30 Denture patients/day. Perfect for Implant Specialist. FP $600,000.

PALMDALE Bank Sale. 4 ops. Great hi identity location.

PALM DESERT 5 ops. Grosses $800,000. Bargain.

PASADENA AREA HMO Grosses $900,000. Storefront, 5 ops. Real Estate available.

REDLANDS Bank Repo run by Internet Marketing DDS. 4 ops low overhead Grosses $30,000/month. Full Price $285,000.

RIVERSIDE HMO Grosses $850,000, low overhead. 9 ops. $1.5 Million potential.

SAN BERNARDINO $1.5 Million potential. Full price $220,000.

SAN DIMAS HMO Hi identity center. Seller refers a lot. $8,000-to-$10,000/mth cap checks.

SAN FERNANDO VALLEY Hispanic practice grossing $1.25 Million. Real estate available.

SAN FERNANDO VALLEY Part-time grossing $300,000. Full time will do $500,000.

SANTA ANA Emergency! Seller says discount and sell. Low overhead strip center. 3 ops.

SANTA ANA LOCATION – COMING UP! Hi identity.

SOUTH ORANGE COUNTY Prestigious Plaza. Modern 1,450 sq.ft. Will be $1.5 Million in 3 years.

SOUTH ORANGE COUNTY $950,000 in 2013. Gorgeous 5 ops. Full Price $795,000.

SOUTHERN CALIFORNIA Grosses $4.5 Million. Prestigious hi identity.

TORRANCE Prestigious Asian Center. High tech, gorgeous. Full Price $350,000.

TORRANCE Grossing $300,000+. Next to hospital.

TORRANCE/GARDENA Chinese DDS. Very profitable. Grosses $200,000. Lots referred out.

YUCCA VALLEY Hi identity (huge sign) 600 sq.ft. 2 op dental building. Full Price $110,000.

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BAY AREA

AC-243 SF Facility: Occupies entire 8th floor of beautiful Downtown SF Fin. Dist. Bldg 2500 sf w/ 7ops **$150k**

AC-335 SAN FRANCISCO: Two great practices for the price of one! Call for Details!!

BG-352 LAFAYETTE: Rare Opportunity! Available Immediately! 1150 sf w/ 4 ops **$265k**

BN-183 HAYWARD: ***Kick it up a notch by increasing the current very relaxed work schedule!*** 1,300 sf w/ 3 ops **$150k**

BN-279 CONTRA COSTA COUNTY: Excellent Merger Opportunity! 2-story. 1,350 sf w/ 3 ops +1 add'l **$60k**

CC-170 SOLANO COUNTY: Near Wine Country! 950 sf w/3 ops **$225k**

CC-307 SOLANO COUNTY: 1/3 Interest in premier practice! One of the most valuable practices on the CA market in years! 6,785 sf w/ 20 ops **$1.035m**

CG-355 NAPA: Looking for Experienced, High-End General Dentist. Collections ~ $1m **$725k**

CN-189 RIO VISTA: In the heart of the beautiful California Delta! 3 ops **REDUCED! $195k**

CN-344 N. SONOMA CO: Long-established, stellar reputation! 2560 sf, w/ 6 ops **$925k**

DC-287 DUBLIN Facility: Space Share Facility with OS. 2ops + 1 add'l, 1100 sf **$125k**

DC-308 ALAMEDA: Great Starter Practice close to 880! 1,100 sf w/ 4 ops **$125k**

DG-116 SALINAS AREA: Large, loyal & stable patient base! 1,400 sf w/5 ops. State-of-the-art Equipment **$175k**

DG-124 MILPITAS: Highly visible. Desirable area. 960 sf w/ 2 ops + 1 add'l **$130k**

DG-348 SAN JOSE Facility: Fully equipped w/add'l $25k in extra equip including software! **$175k**

DG-351 PLEASANTON Facility: Very Appealing and Desirable! 1,000 sf w/ 3 ops. **$95k**

DN-310 SUNNYVALE: Established 24 yrs. Seller retiring! 965 sf w/2 ops + 1 add'l **$75k**

DN-311 PLEASANTON Facility: A great location and superior visibility! 870 sf w/ 3 ops + 1 add'l. **REDUCED! $95k**

DN-331 CASTRO VALLEY: Fully computerized and State-of- the-Art equipped! 1800 sf w/ 6 ops. **$790k**

NORTHERN CALIFORNIA

EG-198 SACRAMENTO: Desirable "Pocket Area". 1,112 sf w/3 ops **$55k**

EG-337 EL DORADO HILLS: Amazing, High-End, THRIVING practice! 7 ops w/ 2,300 sf **$865k**

NORTHERN CALIFORNIA CONTINUED

EN-313 SACRAMENTO Facility Only: Vibrant and desirable area! 936 sf w/ 3 ops **$85k**

EN-340 SACRAMENTO: Large HMO practice! 3,400 sf w/ 10 ops and Plumbed for 1 add'l **$950k**

EN-350 SACRAMENTO: Old-fashioned values and philosophy! 674 sf w/ 1 op. **$85k**

FG-309 ARCATA: Priced at only 44% of collections! 656 sf w/ 2 ops **$185k**

FN-181 NORTH COAST: Well respected FFS GP. Stable patient base. 1,000 sf w/3 ops **$150k (25% int. in bldg. avail.)**

FN-299 FERNDALE: Live and practice on the beautiful North Coast! 1,300 sf w/ 3 ops **$225k (Real Estate: $309k)**

FC-334 NORTHERN CA: Emphasis on prevention. 1,200 sf w/ 4 ops **$480k / Real Estate Also Available!**

GG-320 CHICO: Large, Unique, Originally designed for more than 1 dds! 5,000 sf w/ 7 ops (+2 add'l) **$1.2m**

GG-328 RED BLUFF: Get away from the big City! Established 50 Years! 800 sf w/ 2 ops **$75k**

GN-201 CHICO: Beautiful practice, major thoroughfare, stellar reputation! 1,400 sf w/ 4 ops & room for another **$425k**

GN-244 OROVILLE: Must See! Gorgeous, Spacious. 2,500 sf w/5 ops! Collections over $450k in 2013. **Only $315k**

GN-258 REDDING: Pristine and attractive! Conveniently located! 1,050 sf w/ 2 ops. **$215k**

GN-324 YUBA CITY Facility: Newly updated! 1,704 sf w/ 4 ops, **Motivated Seller! $75k**

GN-354 YUBA CITY: Well-established practice and building! 2670 sf w / 6 ops + 1 add'l **$325k (Real Estate: $450k)**

HG-298 REDDING FOOTHILLS: **HEALTH FORCES SALE!** Includes Cerec! 2,000 sf w/ 5 ops **ONLY $100k / Real Estate Also Available!**

HN-213 ALTURAS: Close to Oregon Border. FFS practice is 2,200 sf w/ 3ops +1 add'l **$115k**

HN-197 EAST LODI FOOTHILLS: Two practices - One great price! Call for details! **$595k**

HN-280 NORTHEASTERN CA: "Only Practice in Town" 900 sf w/ 2 ops **$110k**

HN-290 PLACERVILLE: Embrace the lifestyle and build your success story here! FFS. 1,400 sf w/ 4 ops **$210k**

HN-317 SIERRA FOOTHILLS: "50% Buy-in" in a desirable Foothill community. 2,400 sf w / 6 ops **$525k**

CENTRAL VALLEY

IC-277 STOCKTON & TRACY: 2 Quality FFS Practices **$600k Call for Details!**

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SALES

CENTRAL VALLEY CONTINUED

IG-067 STOCKTON: Fully computerized, paperless, digital. 5,000 sf w/10 ops **REDUCED! Now ONLY $325k**

IG-292 TRACY: PPO/HMO, Family Oriented, 1,300 sf w/ 4 ops Over $200k in collections in 2013 **$129k**

IN-297 MODESTO: Pristine, contemporarily designed medical/prof ctr. 1,980 sf w/ 4 ops. **PR: $475k / RE : $425k**

IN-332 MADERA: Perfect Local in the "heart" of CA. 1,805 sf w/ 4 ops. **$399k**

IN-338 LODI: Recently remodeled. Desirable Downtown location. 1,000 sf w/ 4 ops **$340k**

IN-345 MODESTO: Long-standing tradition of quality care. 3016 sf w/ 5ops + 1 add'l. **$495k**

JN-251 FRESNO: Dedicated to delivering the highest quality of care! 1,565 sf w/ 4 ops **$140k**

JN-259 FRESNO Facility: **Newly Remodeled!** Low rent & overhead! Would cost much more to duplicate! 1,197 sf w/ 3 ops + 1 add'l. Seller Motivated! **$45k**

JG-261 TULARE CO: Family-oriented, desirable locale! Seller willing to stay for transition! 730 sf w/ 3 ops **$325k**

JN-295 VISALIA: Practice & Real Estate 2,000 sf w/ 5 ops **PR: $185k RE: $300k**

JN-316 CLOVIS: "The best of all worlds!" Huge, like new Practice! 2,501 sf w/10 ops **$700k**

SPECIALTY PRACTICES

I-7861 CENTRAL VALLEY Ortho: 2,000 sf, open bay w/ 8 chairs. Fee-for-Service. **$370k**

I-9461 CENTRAL VALLEY Ortho: 1,650 sf w/5 chairs/bays & plumbed for 2 add'l **$180k**

EN-203 SACRAMENTO Oral Surgery: Highly efficient. 3,000 sf w/ 4 ops **ONLY $235k**

EG-225 SACRAMENTO Ortho: Well-maintained, single-story Medical/ Dental complex. 1,200 sf w/ 4 chairs **$95k**

DG-264 SAN JOSE Ortho: $300-400k in build-outs alone! 1800 sf w/ 5 chairs. **REDUCED! $245k**

GN-304 NORTHERN SACRAMENTO Pedo: Well established, highly esteemed. 1,800 sf w/ 4 ops **$595k**

DN-293 LIVERMORE Perio: Specialty of Periodontics, Dental Implantology and Oral Medicine. 2,200 sf w/ 5ops + 1 add'l. **PR: $650k RE: TBD**

AC-325 SAN FRANCISCO Endo: Associate + Buy-In Opportunity in warm and caring environment. **Call for details!**

BC-336 CONTRA COSTA CO Perio: 1,440sf, 4 ops +1 Great Location! **Call for Details!**

CC-346 SO MARIN CO Perio: 1,142 sf w/ 3 ops. Meticulously maintained! **$270k**

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ASK THE BROKER

As the Year Comes to a Close….

The past few year-end issues were interesting. Two years ago we saw a rush of sales in December occur as there was talk in congress that the capital gains tax increase might be retro-active. That rumor caused many sellers to close in December that otherwise would have closed in January. The retro-active part of the tax increase did not happen, but the tax increase did happen last year. I am not sure if the 5% increase in the tax had any effect on any seller's retirement plans, but we are still seeing many aging dentists hanging on longer than they did prior to the economic shake-up of 2008.

As we approach the end of the year, interestingly enough, it is still a *"seller's market"* out there. Having said that, practices in the smaller, rural areas still take more time to sell and the facility-only opportunities without patients are not moving as well as they had in the pre-economic shake-up, even in the larger urban markets. At some point in the next few years, hopefully sooner than later, we do expect a large increase of inventory as the baby boomers who graduated in the late 70's and early 80's will finally let go. I believe we are just starting to see a more normalized market and sellers that have been hanging on are finally starting to decide to hang up their drills.

Here is my year end advice for Sellers

If your practice is currently on the market or you are contemplating selling your practice next year, ***finish the year strong***!! Lenders and Buyers value your practice almost exclusively on the most current year-end P&L. Try ***not*** to take too much time away from the office until January. Make all of your December bank deposits on time and try to have them posted ***before*** January, as opposed to some accountant's advice for you to wait until January so that the tax burden is delayed for a year. If you are currently in contract, most accountants will again advise their sellers to close in January. If you are thinking of selling next year, begin the process to put your practice in tip-top condition with strong financials and "ready to market curb appeal" in mid-to-late January, which is traditionally the busiest time of the year for buyers coming into the market!

Here is my year end advice to Buyers

If you are frustrated searching for the right opportunity, we are expecting a healthy surge in listings and our inventory sometime soon. I expect that this activity will continue to increase. Sellers who have been holding on may decide that it is time to finally retire next year as they probably realize that taxes and expenses will only increase in the future. Their investment portfolios should have rebounded from the 2008 crisis and hopefully they can now consider retirement on their own terms!!!

Again, I wish you much success and continued prosperity for the years ahead and a safe and happy holiday season with the people you care about.

Timothy G. Giroux, DDS is currently the Owner & Broker at **Western Practice Sales** and a member of the nationally recognized dental organization, ADS Transitions.
You may contact ***Dr Giroux at*: wps@succeed.net or 800.641.4179**

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4038 SAN JOSE GP

Established GP in O'Connor Hospital area. Modern, well appointed office in 1,800 sq ft. 5 ops, 4 fully equipped. 4 day doctor work week. Grossing over $1M. Asking $864K.

PENDING

4058 SAN FRANCISCO GP

Sunset neighborhood practice offering 35+ years of goodwill; located on a well-travelled corner, with clearly visible signage. Recently remodeled - clean, modern, gorgeous office with 4 fully equipped ops in 1,500 s. ft. 2014 annualized gross receipts $670K with adjusted net of approximately $210K. Seller relocating out-of-state, but willing to help for smooth transition. Asking $515K.

4033 PETALUMA GP

Owner retiring looking to transition 41 year-old practice to conscientious & dedicated dentist. ~1,000 active pts. avg. 7 new pts./month, 3.5 doctor days & 5 hygiene days per/wk. 2013 GR $683K+. Asking $477K.

SOLD

4032 SOUTHERN PENINSULA GP

Well established GP located in highly desirable area. Beautiful 4 op office in lovely professional bldg. with excellent visibility on major cross street. 3 Dr. days & 3 hygiene days/week. 4 year average GR $391K. Great upside potential. Asking $300K.

SOLD

4030 MODESTO GP

Well-established & well run general practice available immediately. 2,500+ active pts. 4 year avg. GR approx. $1,275,000. Seasoned staff, 10 hyg. days/wk, 4 Dr. days/wk. Beautiful 2,293 sq. ft. dental office in seller owned building with 6 fully-equipped ops. digital x-ray & regular dental equipment upgrades. Asking $837K.

SOLD

4054 MID-PENINSULA ORTHO

This established orthodontic practice is located in desirable centrally located area with a solid economic base, numerous amenities & diverse residents. Average GR $700K+ with only 2.5 doctor days/week & genuine potential for growth. The practice is offered with newly re-modeled, gorgeous free-standing professional building w/private garden & dedicated parking surrounded by dental & medical professionals in a commercial & residential mix neighborhood. The office is state-of-the-art with 5 (open bay) ops in approximately 1,600 sq. ft not including an additional 300-400 sq. ft. of storage space. Both practice and building are for sale. Asking $591K practice, $937K building.

PENDING

4050 SANTA ROSA GP

Seller retiring & ready to transition well est. GP w/ focus on restorative care. Spacious 2,100 sq. ft., elegant & modern office in seller owned building located on prominent corner of a well-traveled intersection close to shopping areas. 6 fully-equipped ops. Dedicated parking. Excellent leasehold improvements. Approximately 1,900 active pts. $1.1M+ avg. GR w/66% overhead & 4 doctor days. Asking $751K.

SOLD

4051 CENTRAL COAST PROSTHO

Well-established practice located in California's gorgeous Central Coast area. Beautifully appointed, spacious 1,568 sq.ft. office with 4 fully equipped ops, pros lab and other amenities. Situated just minutes from the ocean and <5 miles away from one of California's historic Mission Cities, this practice is nestled in a highly desirable community. 2013 gross receipts were $1.2M+ and 2014 is annualized at $1.3M+ on a 4 day doctor workweek, w/4 days of hygiene/week. Approx. 15 new patients a month and ~1,500 active patients (all fee-for-service). Owner/doctor is willing to help Buyer for smooth transition.

4040 FAIRFIELD GP & BUILDING

Well-established GP located in excellent, upscale area. 4 fully equipped ops in 1,615 sq. ft. 2013 GR $335K. 2014 annualized GR $433K with adj. net of $183K. Approx. 700 active patients, all Fee-for-Service (no PPOs, no HMOs). Retiring doctor willing to help Buyer for smooth transition. Practice listed at $210K. Beautifully appointed building is also listed for sale, appraised value and listing price $410K.

PENDING

UPCOMING:

4046 SAN JOAQUIN VALLEY ENDO & GP

4056 SOLANO COUNTY GP

4060 SANTA CRUZ COUNTY GP

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PERIODONTICS

Management of aggressive periodontitis

Silva-Senem MX, Heller D, Varela VM, Torres MC, Feres-Filho EJ, Colombo AP. Clinical and Microbiological Effects of Systemic Antimicrobials Combined to an Anti-infective Mechanical Debridement for the Management of Aggressive Periodontitis: A 12-Month Randomized Controlled Trial. *J Clin Periodontol* 2013 Mar; 40(3):242-51.

Background: Antimicrobial resistance and other disadvantages associated with overuse of systemic antibiotics in the management of periodontitis has led to studies investigating a nonantibiotic approach using mechanical therapy with only local antimicrobials such as chlorhexidine (CHX). However, the efficacy of such therapy without systemic antibiotics in clinical and microbiological outcomes in generalized aggressive periodontitis is not well understood.

Purpose: The authors conducted a randomized, placebo-controlled double-blinded clinical trial to compare the clinical and microbiological outcomes in generalized aggressive periodontitis treated by enhanced mechanical therapy (described in Methods section) including local antimicrobials with or without systemic antibiotics (amoxicillin 500mg and metronidazole 250mg thrice daily for 10 days).

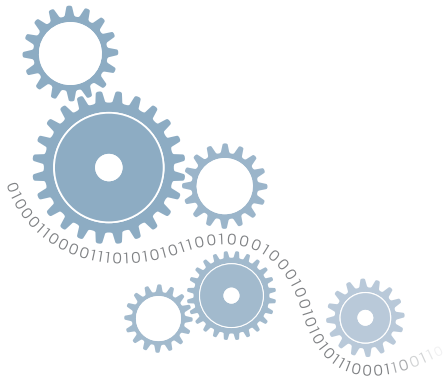
Methods: This study included 35 subjects (17 controls and 18 test subjects). All subjects received two consecutive weekly sessions of oral hygiene instructions to lower their plaque to ≤20 percent of all dental surfaces. Active treatment consisted of two phases: In phase I (enhanced mechanical therapy), all subjects received supra- and subgingival debridement with ultrasonic instruments in two one-hour sessions with pocket irrigation using 0.2% CHX gel. Subjects were also instructed to rinse and gargle with 0.12% CHX solution twice a day and to tongue brush with CHX gel twice a day for 45 days. After phase I, subjects were randomly allocated to test group (systemic antibiotics group with amoxicillin 500mg and metronidazole 250mg thrice daily for 10 days) and control group (placebo tablets). One week after phase I, phase II treatment was started, which consisted of one-hour quadrant scaling and root planning along with irrigation with CHX gel, and which was completed in four to six weeks. During follow-up visits at three, six and nine months, oral hygiene instructions were reinforced and sites with probing pocket depths >4mm were re-instrumented. DNA-DNA hybridization technique was used for microbial analyses in subgingival plaque samples obtained at baseline, three, six, nine and 12 months.

Results: There were no significant differences between test and control groups in terms of demographics (age and gender), baseline clinical parameters, smoking status and side effects. With respect to clinical parameters, the authors reported significant reductions in all parameters in both groups, with one exception being the percentage of sites with clinical attachment level (CAL) between 4 and 6mm. There were also no significant differences between the test and control groups in mean number of residual pockets. Further analysis of severity of residual pockets showed that the test group exhibited a trend toward shallower residual pockets. The microbiologic data revealed similar results in both the test and control groups: a decrease in periodontal pathogens and an increase in beneficial bacterial species. However, some periodontal pathogens were noted in high levels, with persistent disease in both the test and control groups.

Conclusion: Enhanced mechanical therapy combined with local antimicrobial therapy was comparable to treatment that also included systemic antibiotics. However, sites that showed persistence of disease had increased numbers of periodontal pathogens and non-oral bacteria and low numbers of beneficial oral bacteria, which is consistent with previous studies. The limitations in this study include a small sample size and the use of a low dose of metronidazole (250mg compared to 400mg or 500mg in other studies that showed beneficial effects of metronidazole). Another limitation is the fact that repeated instrumentation of pocket depth >4mm throughout the study period could have affected the observations noted. Nevertheless, the nonantibiotic approach applied in this study is encouraging to overcome global problems in the management of generalized aggressive periodontitis, such as antibiotic resistance and depletion of beneficial intestinal bacteria associated with systemic disease. However, this study has to be replicated without the limitations described above and evaluated longer than 12 months, as the disease course of generalized aggressive periodontitis has shown signs of recurrence over longer periods of observation.

Clinical significance: Widespread use of systemic antibiotics for treatment of patients with aggressive periodontitis does not provide major additional clinical benefits compared to mechanical debridement and anti-infective therapy. The use of systemic antibiotic therapy for treatment of periodontal disease should be restricted to patients who may show resistance to initial mechanical and anti-infective therapy or to a subpopulation of patients based on clinical presentation and complete consideration of disease history and contributing factors.

—Satish Kumar DDS, MDSc, and Kian Kar DDS, MS



A look into the latest dental and general technology on the market

Oral-B App (P&G Productions, Free)

New for iTunes and the Android store, Oral B's dental app is a one-stop shop to help individuals maximize the use of their Oral-B electric toothbrushes. To gain full use of the app's functions, one needs to have specific Oral-B electric models with Bluetooth connectivity; however, certain functions can be used without a compatible electric toothbrush. With Oral-B's Bluetooth ability and sound-recognition functionality, the app recognizes the brush based on sound frequency. The brush can be set to vibrate when it's time to move to a section in the mouth or a green light signal will flash. Up to 20 brushing sessions can be synced and used to show brushing statistics by day, week or month summaries. Brushing and flossing can be customized with reminders, allowing special attention to specific areas. A section on oral health care rounds out the app and contains a number of useful headings and tips to help individuals make their oral health care more complete.

– Darien Hakimian, DDS

comiXchat (Nubis Technology, Free)

Emojis have taken over text messaging chains these days as people move toward using the expressive functions of their smartphones. The new app comiXchat, which is now available for iOS, Android and Windows Phone users, takes that visual concept a step further. The app does this by turning a text chain into a comic strip. Users simply download the app, add a contact by searching by email address (a person can only be invited to chat if they also have the app), type a message and then hit send. The message will then appear in a text bubble above the character you have chosen to represent yourself, like any comic strip. The conversation continues as long as needed. Users can choose from 12 characters. The app has various different environments the characters will appear in and users can adjust the mood of their characters by selecting emotion icons. There are bugs with the app, as it can take some time to load conversations and add friends, but comiXchat isn't meant to replace traditional text messages, just allow for a new, unique visual experience – and it accomplishes that.

– Blake Ellington, Tech Trends editor

Smartphone Users View Devices 1,500 Times a Week

The average smartphone user picks up his or her device 1,500 times per week. This according to a new study conducted by the marketing agency Tecmark. The study, which looked into the habits of 2,000 smartphone users, also found that people are spending more than three hours of their day looking at their phone. Other interesting information pulled from the survey included: nearly one-fourth of smartphone users expressed a sense of being "lost" without having their smartphone; two-thirds of users said they open Facebook and view their timelines without realizing it; the typical user viewed his or her phone for the first time in a day at 7:30 a.m. Tecmark also claims to have discovered that users complete 221 tasks a day on their smartphones, which has decreased the amount of time spent on desktop computers and laptops.

– Blake Ellington, Tech Trends editor

Dental Spanish Guide (Mavro Inc., Free)

When a practitioner or staff member is faced with needing to communicate with the patient without an interpreter, language-assist tools can be extremely useful. The Dental Spanish Guide app was created with this situation in mind, offering a simple and intuitive way to provide language assistance to the dental team for Spanish. The basic and most powerful feature of Dental Spanish Guide is to provide the user with text and audio of the most commonly asked questions of patients in a yes/no answer format. There are lists of questions organized into topics that include pain assessments, treatment plan, X-rays, medical questions and anesthesia, for example. The questions are listed in both English and Spanish. Selecting a question will play an audio clip of the question in Spanish for both the user and the patient to hear. The only Spanish language requirement for the user is to recognize a yes/no response from the patient. "Flashcards" is another feature of the Dental Spanish Guide, which provides an easy way for users to learn dental questions in Spanish. Dental-related questions are displayed in English for the user to practice translating them to Spanish. Flipping the flashcards reveals Spanish translations of the questions displayed. Users can choose to play audio clips of the questions if they need some assistance reciting their Spanish translations. Users can advance through the entire set of dental questions in the various topics available in the guide.

– Hubert Chan, DDS

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