OF THE CALIFORNIA DENTAL ASSOCIATION

Journal

APRIL 2008

Provisional Restorations

Teeth to Implants

Restorative Options

RESTORATIVE SUCCESS

PART 2 OF 2

Treatment Planning

RICHARD T. KAO, DDS, PHD

OF THE CALIFORNIA DENTAL ASSOCIATION
Journal
CDA Journal
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DEPARTMENTS

FEATURES

CDA JOURNAL, VOL 36, Nº4

Winning the Battle, Losing the War

ALAN L. FELSENFELD, DDS

There was encouraging news about the ability of dentistry to prevent and treat oral diseases.

At a recent lunch with a young colleague of mine, Dr. Polly Anna, who graduated from our school, we contemplated the status of preventive dental care in California and, to a lesser extent, in the nation. She proposed a theoretical construct for a dental health care system. Imagine a world where all pregnant women had access to good prenatal care early in their pregnancies. This would translate to good health assessment of the mother, scheduled physician visits, proper nutrition, cessation of noxious habits, prenatal vitamins, and, when indicated, prenatal fluoride.

Following a normal delivery, her infant would have an acceptable birthweight and be able to pursue appropriate well-baby pediatric care, immunizations, and monitoring. It would have a proper diet and live in a fluoridated community. The mother or father would teach the child good oral hygiene habits, and it would have a dental visit with the eruption of his or her first tooth or by its first birthday. Pit and fissure sealants would be applied to those teeth at risk for caries. The mother would not feed the baby cariogenic foods, nor would the child be put to bed with a bottle.

This is a child who would grow to have a good complement of teeth and be free of carious lesions and periodontal disease. All that would be needed from the dental community is a primary care dentist — pediatric or general, an orthodontist for malocclusions, and an oral and maxillofacial surgeon for impacted teeth. Utopian? Not really. This is achievable and occurs in large sections of our population.

The Centers for Disease Control and Prevention issued a recent longitudinal study that reported a comparative analysis of dental disease for two time periods in the last 20 years.[1] There was encouraging news about the ability of dentistry to prevent and treat oral diseases. Tooth decay in permanent teeth in children and adolescents decreased in the later time periods. Pit and fissure sealant use was up. Periodontitis was decreasing in all populations regardless of age. Edentulism declined as people took better care of their teeth. That is the good news.

The data was not all positive. Two areas had negative implications for dental health: The first was the percentage of adults who visited a dentist within the previous year had declined. One could argue that with improving decay and periodontal disease rates, a decline in dentist visits is of minimal consequence. This is fallacious reasoning in that the lack of adequate visits could be a harbinger of future increased in disease.

More troubling is the fact that decay prevalence in primary teeth has increased. The issue is magnified in groups with racial and ethnic disparities, as well as for the impoverished. The reasons for this increase in this young population are speculative. For a subset of our people, this is not the situation. Many communities still have no access to good prenatal care. Fluoridation, while improving markedly in the state is not universal. Bottled water that is so predominant in our culture today is not fluoridated. Low birthweight and sickly children are still being born with numerous medical maladies. Childhood obesity is becoming a national problem. Access to dental care is less than optimal in many areas of our state. Cultural values do not always value good nutrition, proper oral care, or even routine visits to health care providers. There is still plenty of dental disease to be treated. That is the bad news.

A friend of mine used to tell me dentistry is the only profession that would like to put itself out of business. Hyperbole to be sure, but if one considers the overarching emphasis in our education and patient care on prevention of disease, there is a significant truth in this idea. We hope that dental caries and periodontal disease could be eliminated by good health practices throughout all communities. Even with that, the need for dentists to repair the damage already done, or to replace dental restorations that have outlived their useful lives, would be great. All of us, and likely another generation of dentists, would still be able to practice a full and prosperous career. Nevertheless, we would love to see new disease in our children and young adults abate to miniscule levels.

This early increase in caries rates needs to be addressed if we are to continue to see improvement in dental health. School

screening legislation in California, along with the training of general dentists to become comfortable with pediatric care, are two extant solutions. Others need to be developed in cooperation with schools and community resources.

It is not correct professionally to suggest that it is only deciduous dentition that is affected, and this is not an issue. The problem is real and it may be a harbinger of decreasing ability to control disease. Do not be lulled into a false sense of security. We may appear to be winning the battle against dental disease, but we could be losing the war for the next generation. ■■■■

REFERENCES

1. Dye BA, Tan S, et al, Trends in oral health status: United States, 1988-1994 and 1999-2004. National Center for Health Statistics. *Vital Health Stat 11* (248)1-92, April 2007.

Address comments, letters, and questions to the editor at alan.felsenfeld@cda.org.

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Readers Voice Concerns Over Ad

We appreciate the fact you published a letter in the January 2008 issue of the *Journal of the California Dental Association* that was critical of the *Journal*. It is important that a scientific journal have feedback on articles so as to create a forum of discussion that allows for differences of opinion and scientific debate.

We appreciated the publication of an article in the same issue titled "A Special Report: Beginning the Discussion of Commercialism in Dentistry." This was step forward and seemed to address the issues presented in the letter of criticism.

However, on the last page of the article, there was an advertisement that represents commercialism of dentistry in its worst form. As readers, we thought this ad was placed there as a joke or as an example of crass commercialism. But seeing no reference to it in the article, we wondered if there is anyone on your staff who screens advertising for appropriateness. Our concern is that the *Journal* is not reflecting the interests of mainstream California dentists.

With unscreened advertising, the *Journal* could become irrelevant to dentists who choose to practice in an ethical manner.

PHILIP HORDINER, DDS
San Rafael, Calif.
JACK SAROYAN, DDS
San Francisco

Reader Feedback on Commercialism in Dentistry Article

I have read the recent article on commercialism and would like to offer some feedback.

The abstract states "The core theme in the recommendations from the Ethics Summit on Commercialism is that competent, comprehensive, and continuous oral health care is appropriate and should be promoted to the American public." This may be an accurate and conceptually excellent statement, but does not address the topic very well, nor does the article.

If there is concern about negative effects of commercialism, here are my suggestions, all of which invoke the basic economic principles of supply and demand, and also presuppose our great nation continues to practice capitalism:

Our concern is that the *Journal* is not reflecting the interests of mainstream California dentists.

- Increase the compensation package in order to recruit dentists to work in underserved areas. Amazingly, more dentists will become interested.
- Educate dentists that seminar speakers and article authors may be subject to bias if they are making a handsome income from a trade company. I note that very few of the speakers at any seminar I attend have no relationships with trade companies.
- Take great pains in our continuing education courses and journals to make sure speakers and authors have fully and truthfully disclosed all industry relationships that might raise the suspicion of bias. I have seen speakers disclose some, but not all relationships.
- Educate dentists that if a speaker claims "now that you have taken my course, you can do this just as well as a specialist," the speaker may be subject to bias if he is making a handsome profit collecting tuition in his continuing education business. We should also be gentle when we tell our specialist buddy he spent years in residency, but he apparently could have learned everything in one weekend. He's going to feel pretty foolish.
- Educate the public about the obvious hazards of some of the dental treatments being made popular in the media. We should educate on specific procedures mentioned in these reality makeover shows.
- Decrease the supply of both general dentists and specialists. If there is a business problem that has caused some dentists to fall victim to "commercialism" and inappropriate or unnecessary treatments, then we should decrease the supply until dentists are plenty busy serving the public interest, and do not need to seek alternative sources of income. I am not sure this will be popular with the school deans and program chairs or with legislators who may feel that an oversupply of dentists will lower treatment costs, but it should be considered.

MARWOOD M. STOUT, DDS
Oxnard, Calif.

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Matt Mullin

Licorice Root Lollipop Shows Sweet Promise in Reducing Tooth Decay

BY DEBRA BELT

UCLA researchers hope they have created a tooth-friendly candy in a new sugar-free, orange-flavored lollipop containing an extract of licorice root that has shown promise in targeting and killing *Streptococcus mutans*, the primary bacteria responsible for tooth decay.

First reported in 2006, microbiologist Wenyuan Shi, PhD, chair of the Oral Biology Department at UCLA, discovered that compounds from the Chinese herb, *Glycyrrhiza uralensis*, commonly referred to as licorice root, contains active antimicrobial compounds. This ingredient is now infused and available in a bacteria-killing lollipop.

The licorice root extract in this lollipop can effectively kill *S. mutans*, a common bacterium that could release harmful cavity-causing acids. Only 15 milligrams of licorice powder per lollipop eliminates 99.9 percent of this bacteria in the mouth within five to 10 minutes, Shi told the

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The Natural Dentist Announces Anticavity Fluoride Rinse

The Natural Dentist Healthy Teeth and Gums Anticavity Fluoride Rinse strengthens tooth enamel to help minimize the risk of cavities. It is all natural, with no alcohol, artificial sweeteners, dyes, or preservatives. It soothes and protects gums, and preserves mouth moisture with aloe vera gel and glycerin. It kills bad breath germs with xylitol and grapefruit seed extract. It has a minty flavor, with cool menthol freshening, but none of the "burn" or staining of other brands. It will be available at leading retail locations. For more information, go to www.thenaturaldentist.com.

A Red Flag in Going Green

"Green" products are environmentally friendly when used as designed; however, disposing of them can be tricky.

In a Jan. 24 *Wall Street Journal* article by Sara Schaefer Muñoz, the author addressed how people are coping with the need to throw away many products, including "green" products like fluorescent light bulbs, that may pose potential problems in the landfill. According to Muñoz, many retailers, including Best Buy, Home Depot, and Ace Hardware, are embracing a new role as recycling facilitators.

The article also highlighted the problem of mercury in fluorescent light bulbs. By themselves, the bulbs pose little potential hazard, but one environmental expert voiced concern over the impact millions of these bulbs may have being dumped in landfills or incinerated.

To find ways to recycle old bulbs, go to www.earth911.org, and www.epa.gov/bulbrecycling.

Honors

Thomas Schiff, DMD, recently retired from the University of the Pacific Arthur A. Dugoni School of Dentistry, has received a fellowship from the American Academy of Oral and Maxillofacial Radiology. Schiff was recognized for the "noteworthy excellence as described in the Academy By-Laws." Additionally, he was appointed as the department chairperson of the Scottsdale Dental Center under the deanship of Gordon Christiansen.

Thomas Schiff, DMD

UPCOMING MEETINGS

2008	
May 1-4	CDA Spring Scientific Session, Anaheim, 800-CDA-SMILE (232-7645), cda.org.
May 2-3	Evidence-based Dentistry Champion Conference, ADA headquarters, Chicago, ada.org/goto/ebdconf.
May 4	International Conference on Evidence-based Dentistry, ADA headquarters, Chicago, ada.org/goto/ebdconf.
May 6–9	Conference for Oral Health in the Americas, Lima, Peru, http://www.fdiworldental.org/public_health/3_1conferences.html.
July 16-20	56th Annual Meeting and Exhibits, Academy of General Dentistry, www.agd2008orlando.org.
Sept. 12-14	CDA Fall Scientific Session, San Francisco, 800-CDA-SMILE (232-7645), cda.org.
Sept. 24-27	FDI Annual World Dental Congress, Stockholm, congress@fdiworldental.org.
Oct. 16-19	American Dental Association 149th Annual Session, San Antonio, Texas, ada.org.
Oct. 25-29	American Public Health Association Oral Health Section's annual meeting and exposition, San Diego, www.apha.org/meetings.
2009	
May 14-17	CDA Spring Scientific Session, Anaheim, 800-CDA-SMILE (232-7645), cda.org.
Sept. 11-13	CDA Fall Scientific Session, San Francisco, 800-CDA-SMILE (232-7645), cda.org.
Oct. 1-4	American Dental Association 150th Annual Session, Honolulu, Hawaii, ada.org.

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

Lasers Aid in Eliminating Bacteria in Root Canals

High-tech dental lasers used mainly to prepare cavities for restoration now can help eliminate bacteria in root canals, according to research published in the *Journal of the American Dental Association*.

Researchers in Austria credit the development of miniaturized, flexible fiber tips for allowing the laser to be used in endodontic treatment.

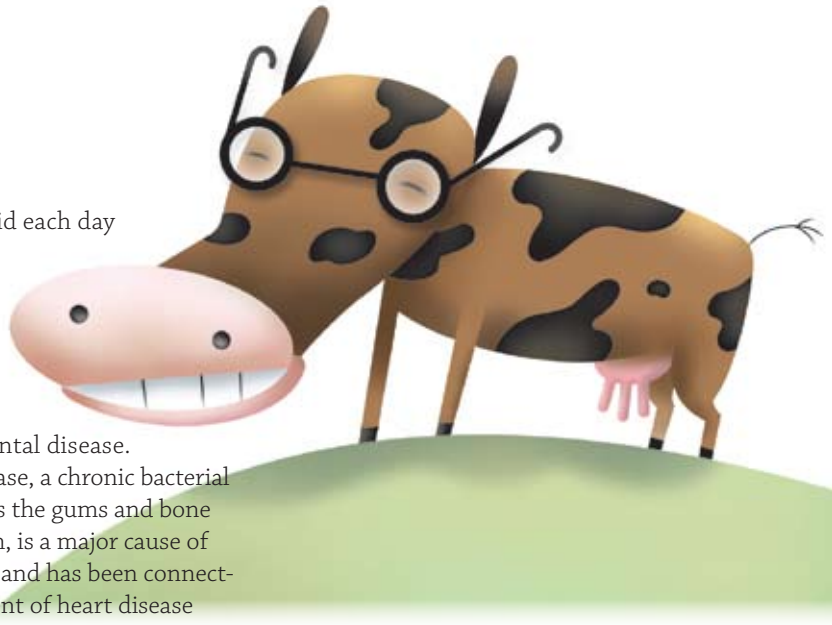
Ulrich Schoop, MD, and a team of researchers in the dental school at the University of Vienna used 60 extracted human teeth with one root each to test the effects of laser irradiation on root canals using an erbium, chromium:yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser. He and his colleagues inoculated the root canals with one of two types of bacteria *(Enterococcus faecalis* and *Escherichia coli)* and then irradiated the canals using either a 1- or 1.5-watt power setting.

The team found that the laser reduced the amount of *E. coli* at the lower power setting and reduced it to below the detection level at the higher setting. It also was effective in eliminating *E. faecalis*.

Researchers also found that the laser removed the smear layer and debris from the root canal walls, and that the temperature rise during irradiation was within safe borders.

The authors concluded that the Er,Cr:YSGG laser may be suitable for cleaning and disinfecting root canals, and that it can be used safely if the common precautions for using lasers are observed and the energy levels and irradiation times are within the proposed range. They also suggested that clinical studies are needed to confirm their laboratory findings.

In a related article published in *JADA*, Roy H. Stevens, DDS, MS, and colleagues at the Kornberg School of Dentistry, Temple University, described their study of an Er,Cr:YSGG laser with a new tip that emits radiation radially. Stevens' team examined the efficiency of this new laser tip in disinfecting root canal dentin walls infected with *E. faecalis*. They found that it significantly reduced the amount of *E. faecalis* in contaminated root canals.



Dairy Products May be Moovelous for Healthy Gums

A recent study published in the *Journal of Periodontology* indicated that routine intake of dairy products may also help promote periodontal health. The study analyzed the periodontal health of 942 individuals and determined those who regularly consumed dairy products such as milk, cheese, and yogurt had a lower instance of gum disease.

Research has suggested that periodontal disease may affect overall systemic health, said study author Yoshihiro Shimazaki, DDS, PhD, of Kyushu University in Fukuoka, Japan. This study reinforces what much of the public already knows, that dairy foods are important in helping achieve a healthy lifestyle, including a healthy mouth.

Study participants aged 40 through 79 were examined on two periodontal parameters that can indicate gum disease, periodontal pocket depth, and clinical attachment loss of gum tissue. Researchers observed that subjects who consumed 55 or more grams of products containing lactic acid each day had a significantly lower prevalence of deep PD and severe CAL, therefore demonstrating a lower instance of periodontal disease.

Periodontal disease, a chronic bacterial infection that affects the gums and bone supporting the teeth, is a major cause of tooth loss in adults, and has been connected to the development of heart disease and increased risk of stroke. It also can contribute to complications from diabetes, respiratory disease, or osteoporosis.

Millions of adults already suffer from periodontal disease, said Susan Karabin, DDS, president of the American Academy of Periodontology. By regularly consuming dairy products such as cheese and milk, something many people do each day, the risk of developing gum disease may decrease. These findings are important since maintaining healthy gums is a critical component to maintaining a healthy body.

New Scenic Relaxation Videos

High-quality DVD images create peaceful visual environment, and ease anxiety of patients in doctor's offices, hospitals, or hospice care facilities. Titles include programs depicting spring; autumn; a day at the zoo; secret courtyards; marine life; beaches; brooks; ponds; and a day in the country. Each HUG Video program lasts about an hour. Dentists and other health care professionals have been reaping the benefits of HUG Videos since 1996. For more information, visit http://www.hugvideo.com.

New Logo May Help Consumers Make Smart Choices

The ADA's new "Smile Healthy" certification program is designed to help consumers identify which foods and beverages are good for oral health.

The just-introduced logo signifies a "smart choice for oral health" and will appear on one-gallon containers of fluoridated bottled water. The ADA anticipates future Smile Healthy product categories could include sugar-free beverages and foods, as well as dairy products.

ADA President Mark J. Feldman, DMD, said "Some people may not live in areas where their drinking water is fluoridated or perhaps they prefer the taste or convenience of bottled water. Now when you see the Smile Healthy logo on bottled water, you know you're doing something good for your oral health."

The ADA has long supported the addition of fluoride in optimal amounts to water to help prevent tooth decay and hopes consumers will look for the Smile Healthy logo when purchasing bottled water.

The first company to be granted a license to use the Smile Healthy logo on one of its products is Water Source One, a large national bottled water manufacturer with 15 production facilities across the United States.

Smile Healthy™

Recognized as a smart oral health choice

ADA American Dental Association

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"Polydopamine coatings can, in turn, serve as a versatile platform for secondary surface-mediated reactions."

Mussel-inspired Polymer Coating Reported

Dopamine is one of several catecholomines or chemical compounds derived from the amino acid tyrosine. In a recent issue of *Science*, National Institute of Dental and Craniofacial Research grantees and colleagues reported they have developed an aqueous, dopamine-rich solution that, through simple dip coating of objects, forms versatile polymer coatings.

Inspired by the composition of natural adhesive proteins in marine mussels, the scientists found their method of dopamine self-polymerization formed thin, surface-adherent polydopamine coatings on a variety of inorganic and organic materials. They included noble metals, i.e., those that are resistant to corrosion or oxidation; oxides; polymers; semiconductors; and ceramics.

The scientists reported, "Polydopamine coatings can, in turn, serve as a versatile platform for secondary surface-mediated reactions... This two-step method of surface modification is distinctive in its ease of application, use of simple ingredients and mild reaction conditions, applicability to many types of materials of complex shape, and capacity for multiple end users."

The production-scale availability of recombinant mussel adhesive proteins will enable researchers to formulate adhesives that are water-impervious and ecologically safe, and can bind materials ranging from glass, plastics, metals, and wood to materials, such as bone or teeth, biological organisms, and other chemicals or molecules, H.G. Silverman wrote in a recent abstract on "Understanding Marine Mussel Adhesion" published in *Marine Biology*.

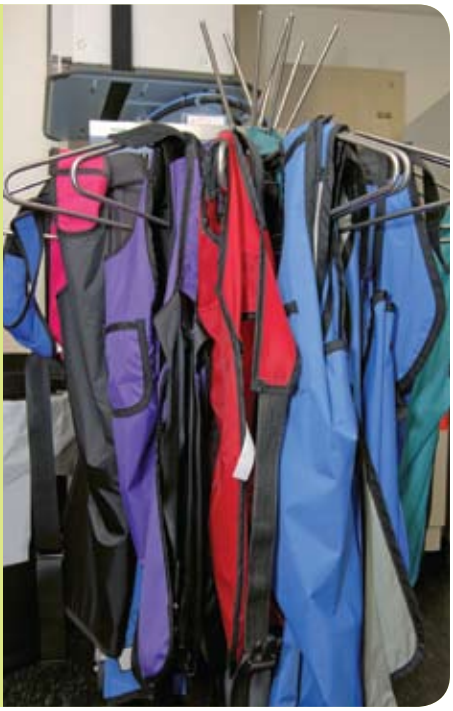
To read more about the paper on mussel-inspired polymer coating go to the "Science News In Brief" menu under "News and Reports" online at www.nidcr.nih.gov/.

Carefully Dispose of Used Lead Aprons

An article in the *Journal of the Michigan Dental Association* has prompted that state's Department of Community Health to advise dentists not to donate lead shields or aprons for use in therapeutic weight training.

Many charity organizations construct weight products for special needs children and may have inadvertently exposed the lead inside the aprons and shields, creating potentially hazardous items.

The State of Michigan is now asking dentists to dispose of surplus aprons and shields as hazardous waste, having them contact their local radiographic film manufacturers, amalgam recyclers or hazardous water haulers for proper disposal.



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Studies Suggest Periodontal Diseases are Ageless to Women

"Thanks" to hormonal fluctuations that occur during various times of their lives, studies now suggest that periodontal diseases are a threat to women of all ages.

One study, published in the *Journal of Periodontology*, looked at 50 women between the ages of 20 to 35 with varying forms of periodontitis. The study found that the women who took oral contraceptive pills had more gingival bleeding upon probing and deeper periodontal pockets than their counterparts who were not taking oral contraception.

"Younger women often think that periodontal disease is a condition associated with old age," said study author Brian Mullally, PhD. "Our study shows that it is very possible for younger women to experience periodontal disease. It is important for women to alert their dental practitioners of any medications they are taking, such as oral contraceptive pills, because it is possible that their oral health may be affected. It might also be prudent where possible for young women to ensure that their periodontal health has been checked before commencing oral contraceptive therapy."

A second study in the *Journal of Periodontology* examined 1,256 postmenopausal women and looked for a potential association between periodontal bacteria and bone loss in the oral cavity. The study results showed that women with periodontal bacteria also were more likely to have bone loss in the oral cavity that often leads to tooth loss if not treated.

"Our study's findings are important for postmenopausal women because they suggest that good periodontal health is extremely important in the postmenopausal years," said Renee Brennan, PhD, study author.

New Technology Ventures Launched

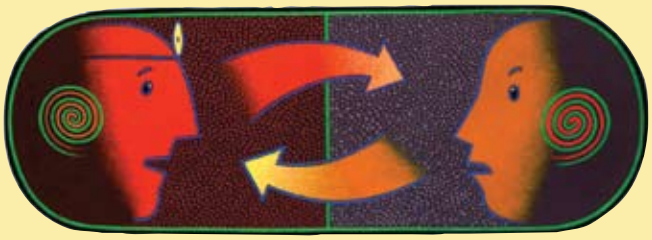
The Academy of General Dentistry has launched three new technology ventures on its Web site, all of which are member benefits that allow education and interaction. GD, general discussion, is an area where members can review clinical, peer-reviewed case studies and dialogue with colleagues about the findings; AGD Podcasting, is a series of interviews with dental experts; and a member blog, The Daily Grind, which is available to the public.

In GD, peer-reviewed case studies, published exclusively on the AGD Web site, will be uploaded on a bimonthly basis so that members can review the research as well as discuss the findings with colleagues to learn even more.

The first case study, "Nickel sensitivity: A case report," written by Gary S. Berkowitz, DDS, and Ronald J. Lehane, DDS, MS, describes one patient's sensitivity reaction to the metal part of a crown and what was done to correct the problem.

"Creating a section of the Web site where members can view new resear increase the education of our members," says Norm Magnuson, DDS, FAGD, chair of the AGD's Publications Review Council.

AGD Podcasting is available for members to download on the AGD Web site. Wes Blakeslee, DMD, FAGD, conducts interviews with notable general dentists and specialists. The first interview was with Michael S. McCracken, DDS, PhD, director of Graduate Prosthodontics at the University of Alabama at Birmingham.



Stuck for Something to Say?

The National Maternal and Child Oral Health Resource Center at Georgetown University has a new resource to help dental professionals communicate with patients of limited literacy.

"A Way with Words: Guidelines for Writing Oral Health Materials for Audiences with Limited Literacy" offers suggestions on how to set an appropriate tone, choose words, craft sentences, lists, headings, and paragraphs that optimize communicating effectively with those with limited literacy. A list of resources for more information is included, as well as how to design documents and presenting unfamiliar terminology.

Single or multiple print copies of this resource are available at no charge from the HRSA Information Center, P.O. Box 2910, Merrifield, Va., 22116; (888) ASK-HRSA (275-4772); fax: (703) 821-2098; or e-mail: ask@hrsa.gov. Electronic copies are available from OHRC Web site.

Proprietary Handpiece Lubrication Oil

The FDA has certified Handpiece Experts proprietary lubricant oil for use with all handpiece makes and models. Dental handpieces are high-performance precision cutting instruments that rotate a bur at more than 400,000 rpm. Such a high-friction environment causes premature wear on handpiece components and is a major cause of instrument failure. Handpiece Experts Oil reduces friction; contributing to prolong handpiece life. For additional information, visit www.handpieceexperts.com, or contact Mark Scott at (866) 937-882, ext. 105.

LOLLIPOP, CONTINUED FROM 243

Daily Bruin, UCLA's daily newspaper.

Before the growth of cavities, harmful bacteria in the mouth produce acids that create holes in the outermost layer of the teeth. *S. mutans* is one of the more virulent cavity-causing bacteria, and the licorice root extract specifically kills only the harmful bacteria in the mouth, not other beneficial bacteria, said Aria Eshraghi, a microbiology graduate student who worked with Shi in the past.

Shi's research, as reported in the *Journal of Natural Products*, published by the American Chemical Society and the American Society of Pharmacognosy, also determined that dental plaque per se is not bad for teeth, as long as the decay-causing bacteria are not present in it. Shi found that plaque can actually act as protection from the recolonization of the bad bacteria.

Shi said his study provides a scientific basis for the age-old practice common in China and other cultures of chewing licorice root.

The lollipop idea originally derived from a discussion between Shi and an executive of Delta Dental about trying to use medical rather than surgical approaches to combat tooth decay. The discussion led Delta Dental to offer Shi $1 million for his study. Since then, the company has provided close to $10 million for the lollipop project.

Since the inception of the project, it has not been easy for Shi and his researchers to meet the expectations of big corporations. The lollipops had to not only please consumers, but also garner positive feedback from many other groups such as clinical trials and research staff.

There are reasons why the special licorice root is extracted and pulverized into a lollipop. The lollipop form gives fewer chances for consumers to choke, so it is better than in candy or gum form. Also, for candy or gum, the ingredient could only be released briefly, making them less effective than the longer-lasting lollipop, Shi said.

Shi sees his lollipop as part of a trend toward medicined dentistry, which means less surgical approaches to dental problems, he said.

The lollipop is now available online for anyone to buy via the Web site of C3 Jian, a research company. Within the next year, Shi thinks that they could be in drug stores.

— Derived from reports in the *UCLA Daily Bruin, Reuters Health*, and *Journal of Natural Products*.

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IMPLANT TREATMENT PLANNING CONSIDERATIONS

RICHARD T. KAO, DDS, PHD

GUEST EDITOR

Richard T. Kao, DDS, PHD, is in private practice in Cupertino, Calif. He also is associate clinical professor at the University of California, San Francisco, School of Dentistry, and the University of the Pacific Arthur A. Dugoni School of Dentistry.

As dental implants become a more accepted treatment modality, there is a need for all parties involved with implant dentistry to be familiar with various treatment planning issues. Though the success can be highly rewarding, failure to forecast treatment planning issues can result in an increase of surgical needs, surgical cost, and even case failure. In this issue, the focus is on implant treatment planning considerations.

Proper provisionalization during implant site preparation and osseointegration phase is essential. Though it is important for the patient's appearance and function, it is even more important in that it cannot impinge on the healing tissue. The first paper provides a review of various interim prostheses and its indication for use. More importantly, there should be active participation of the implant surgeon during the treatment planning phase of the provisionals.

The transitioning of patients from a dentate state to implant-supported restorations requires much planning. In the second paper, Dr. Arun Sharma and his colleagues provide insights to protocols for case transitioning and treatment options. This article will provide readers with a better understanding of the complexities involved with the smooth transitioning of a patient during this emotionally and functionally difficult period.

Two papers deal with how the quality of life and function can be improved with the use of dental implants in our partially or fully edentulous patients. Dr. Don Curtis and colleagues review how edentulism can result in both diminished level of masticatory function and compromised quality of life. Clinical examples of how implants utilized in various prosthetic

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designs can correct these problems are reviewed. In the fourth paper, Dr. Eugene LaBarre describes how the simple use of mini-implants can significantly improve the function of mandibular full dentures.

The last paper focuses on dental cone beam computed tomography. Jerome Peck and Dr. Greg Conte review the important of using CBCT for pre-treatment implant evaluation and the decision-making process. The use of this technology has expanded to be used in conjunction with virtual treatment planning software to design surgical templates so that implants can be placed in ideal prosthetic position. Though this article is not meant as a "cookbook" on the use of this technology, it will familiarize the readership about the potential tools available for implant treatment planning.

Clinicians involved with various aspect of implant dentistry will find these articles useful and informative. The articles will increase one's knowledge of implant treatment planning and necessary ingredients for clinical success. ■■■■

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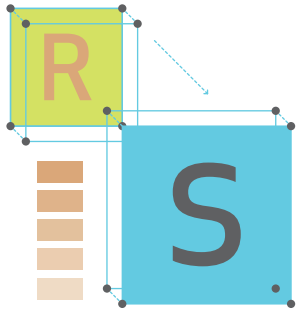

Provisional Restorations: A Key Determinant for Implant Site Development

GREGORY J. CONTE, DMD, MS; MARK C. FAGAN, DDS, MS; AND RICHARD T. KAO, DDS, PHD

ABSTRACT Provisional restoration and interim prosthesis have a significant role in reconstructive dentistry. Esthetics and function of the appliance or restoration are usually the key elements considered in the design and fabrication. While esthetics and function certainly need to be addressed, it is also essential to understand the impact of an interim prosthesis on early hard and soft tissue healing following bone grafting and alveolar ridge augmentation procedures.

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The healing events following tooth extraction have been well documented in the literature.[1-3] Recent studies have demonstrated that horizontal ridge resorption often exceeds 3 to 4 mm within the first six months, and that buccal-lingual ridge collapse and significant ridge atrophy may continue up to 12 months postextraction.[4-6] This becomes especially problematic when implant restoration is planned within the esthetic zone. Nevins et al. showed that 71 percent of anterior extraction sites demonstrated a loss of more than 20 percent of the buccal plate up to three months following extraction.[7] This loss of buccal bone is significant because optimal esthetics can only be achieved if sufficient bone and soft tissue are present at the time of implant placement.

Several procedures have been developed in recent years to help either to preserve the alveolus at the time of tooth extraction, or to augment the edentulous alveolar ridge prior to implant placement, or restoration with a fixed partial denture.[8-10] Socket preservation can be defined as a procedure using bone graft substitutes or guided-bone regeneration in an effort to help prevent buccal-lingual ridge collapse of a preserved tooth socket following extraction. This procedure requires minimally traumatic tooth removal and complete preservation of the labial/buccal plate of bone, but becomes a socket augmentation if the labial/buccal plate has been damaged upon tooth removal or due to pathology. This can be a larger, more difficult procedure that usually requires flap elevation. Alveolar ridge augmentation can be defined as hard or soft tissue augmentation of an atrophied alveolar ridge.

Soft tissue augmentation can be done utilizing autogenous-free or connective

tissue grafts, rotated pedicle grafts, or soft tissue allograft material. Hard tissue augmentation can be achieved by a variety of different techniques and graft materials. These can include both autogenous and allogenic bone blocks, the use of particulate bone grafting substitutes, and guided-bone regeneration. It is important to distinguish between these procedures because different grafting techniques are often used. The course of healing is not the same and early pressure from an interim prosthesis will cause significant resorption of the graft material.

Socket Preservation Procedure

FIGURES 1-3 outline an example of a socket preservation procedure. In this case, the upper left lateral incisor was treatment planned for extraction due to severe root resorption at the apex. The tooth was removed with minimal trauma using periotomes and root pressure forceps. The area was thoroughly debrided, and a very thin but complete labial plate was detected with a bone curette. A collagen membrane (BioMend Extend, Zimmer Dental Carlsbad, Calif.) was cut and adapted to cover the labial bone from inside the socket.[11] The membrane was trimmed to a configuration that when flipped over would cover the socket and extend 2 mm into the undermined soft tissue. Bone graft material (Puros — cancellous mineralized bone allograft-Zimmer Dental) was loosely packed into the socket and the membrane was positioned to cover the graft material and fixated with 6-0 chromic gut suture. A temporary removable partial denture with a ridge lap pontic was placed and the pontic area was relieved so that there was no contact with the membrane covering the socket (**FIGURE 4**).

It is very important to keep the pontic at least 1 to 2 mm away from the

FIGURE 1A. Preoperative view. Upper left lateral incisor planned for extraction due to severe root resorption.

FIGURE 1B. Extracted upper left lateral incisor. Note the severe root resorption at apex.

FIGURE 2A. A collagen barrier membrane is cut to a shape that can fit into extraction socket and cover the defect.

FIGURE 2B. The membrane is positioned into the socket with the long, narrow portion up against the buccal wall of the socket. Particulate bone graft material is packed into the socket up against the membrane.

FIGURE 3A. The membrane is flipped to cover the socket and tucked into the undermined palatal tissue. It is sutured on the palatal aspect with 6-0 resorbable suture.

FIGURE 3B. Buccal view shows completed socket preservation with minimal trauma.

FIGURE 4A. Acrylic removable partial denture has been adjusted to create a ridge lap pontic.

FIGURE 4B. The pontic on partial denture is reduced slightly to allow for a minimum of 1 mm clearance over the membrane covering the socket.

FIGURE 5A. Ten-day postop showing membrane degradation and migrating soft tissue.

FIGURE 5B. Note the excellent tissue response.

FIGURE 6A. Three months' postextraction and socket preservation procedure.

FIGURE 6B. Conversion to ovate pontic in temporary partial denture for gingival shaping.

FIGURE 7A. Three-dimensional NewTom volumetric tomography of socket preservation shows excellent ridge width for proper implant placement.

FIGURE 7B. Implant placement with a flapless approach.

FIGURE 8A. Completed clinical and radiographic views.

FIGURE 8B. Note the excellent tissue health and contour around the implant supported crown.

membrane during the healing phase. The exposed membrane will break down as the epithelium migrates to close the wound. Also, there is healing within the socket that will cause expansion and extrusion of some of the graft material. Pressure from an interim prosthesis at this stage can lead to incomplete bone formation. It generally takes about two weeks for the soft tissue to close over the socket. Transition to an ovate pontic for soft tissue development can begin at three months with implant placement at four months postextraction (**FIGURES 5-8**).

Another well-documented socket preservation technique utilizes bovine particulate graft material and a collagen barrier placed within the extraction socket.[12] An ovate pontic design in a removable or fixed temporary partial denture is used to put pressure on the collagen barrier to seal the socket (**FIGURES 9-11**). This technique is most effective in cases where thick alveolar bone and soft tissue are present following tooth extraction. Care must be taken if this technique is to be used in cases where the soft tissue and underlying alveolar bone are thin. Too much pressure from the pontic can cause excessive hard and soft tissue loss resulting in a compromised esthetic outcome (**FIGURES 12-13**).

Socket Augmentation and Ridge Augmentation Procedures

Socket augmentation and ridge augmentation is much more difficult than the socket preservation. Socket augmentation requires regeneration of damaged or missing labial/buccal alveolar bone upon tooth extraction (**FIGURE 14**), while ridge augmentation is done to regenerate and restore atrophic alveolar ridges. Full thickness mucoperiosteal flaps with vertical and periosteal releasing incisions are needed to secure primary wound closure.

FIGURE 9A. The maxillary central incisors presented with advanced attachment loss due to severe localized periodontitis.

FIGURE 9B. Occlusal view of extraction sockets following tooth removal with minimal trauma.

FIGURE 10A. Bio-Col technique used to fill the extraction sockets. The sockets are grafted with particulate bovine bone graft material and sealed with a collagen sponge.

FIGURE 10B. A temporary removable partial denture with ovate pontic design is utilized as an interim prosthesis. This design rationale is used to support the labial tissue and preserve soft tissue contour.

FIGURE 11A. Ten-day postop. Early healing looks favorable. Good preservation of soft tissue architecture.

FIGURE 12A. Healing at six weeks. Note the change in pontic height from the previous picture.

FIGURE 12B. Extensive loss of hard and soft tissue. A secondary alveolar ridge augmentation procedure had to be completed prior to final restoration.

FIGURE 13A. Clinical and radiographic appearance of completed restoration.

FIGURE 13B.

Advanced surgical principles and guided-bone regeneration techniques are needed to completely restore lost hard and soft tissue. A socket augmentation technique utilizing small bone screws for space maintenance is described in **FIGURES 15-22**. The maxillary incisors were extracted due to advanced periodontal disease. Significant osseous destruction and loss of labial bone was evident. Following degranulation, two bone screws (Osteomed, Shirley, N.Y.) were placed in the interseptal area and positioned vertically so that approximately 3 to 4 mm of the screws were present above the existing alveolar bone (**FIGURE 16**). The area was grafted with demineralized bone allograft (Regenaform RTI, Gainesville, Fla.) and covered with two layers of a resorbable collagen barrier (Bioguide Osteohealth, Uniondale, N.Y.). The area was closed primarily and allowed to heal for five months prior to implant placement.

The bone screws function to keep the membrane and soft tissue from collapsing into the space. Space maintenance is one

FIGURE 14A. Vertical root fracture of upper left central incisor leads to extensive bone loss.

FIGURE 14B. The tooth is removed and a socket augmentation procedure is performed. Note the flap design with mesial and distal vertical incisions for access to the defect.

FIGURE 14C. Re-entry at six months demonstrates complete osseous regeneration

essential requirement for guided-bone regeneration and vertical bone growth. Passive primary closure over the graft site is another. This often requires large flaps and periosteal releasing incisions that can induce significant postoperative swelling. The interim prosthesis must be designed to accommodate the edema, which often can last for several days.

Too often, a temporary removable partial denture is fabricated by the restorative dentist in advance of the augmentation procedure and delivered to the surgeon's office. Significant time is spent by the surgeon reducing the appliance to allow enough space to keep pressure off the surgical site. This results in severe destruction of the prosthesis and a new one usually has to be fabricated, adding cost to the procedure.

The surgeon needs to play an active role in the decision-making for the

FIGURE 15A. Clinical and radiographic appearance of a case demonstrating localized aggressive periodontitis.

FIGURE 15B. The maxillary anterior teeth have severe attachment loss and poor prognosis.

FIGURE 16A. The maxillary anterior teeth are removed and two 12 mm bone screws are placed in the interseptal areas.

FIGURE 16B.

FIGURE 17A. The socket defects are filled and bone graft material is added to the level of the bone screws. The graft material is covered by collagen barrier membranes.

FIGURE 17B. Passive primary closure with interrupted and mattress sutures.

FIGURE 18. An Essix appliance is placed immediately following the surgical procedure.

FIGURES 19A. A resin-bonded fixed provisional restoration is fabricated in the laboratory and is placed after initial swelling from procedure has subsided.

FIGURE 19B

FIGURE 19C.

interim prosthesis in these types of advanced augmentation cases. Communication should take place at the treatment planning phase with the surgeon describing the procedure and the healing events that will follow. Often, two types of interim prosthesis are needed and should be planned for. An Essix appliance can be placed immediately and used for two to four weeks following an augmentation procedure (**FIGURE 18**). It is a cost-effective appliance that most patients will tolerate for a short time. It is somewhat rigid, easy to fabricate and to adjust. Since it is tooth borne, no pressure is applied to the surgical site under function and pontic height can be adjusted easily. The second interim prosthesis can be placed two to four weeks following the augmentation, depending on the size of the graft and needs of the patient. A removable partial denture can be used for smaller graft sites (single tooth) but a fixed prosthesis should be used for the larger augmentations, especially in the esthetic zone (**FIGURES 19A-C**). Movement from a removable prosthesis will result in resorption of the graft leading to reduced bone volume and a compromised restorative and esthetic outcome.

FIGURES 20A. Clinical presentation at five months following extraction and socket augmentation procedure.

FIGURE 20B.

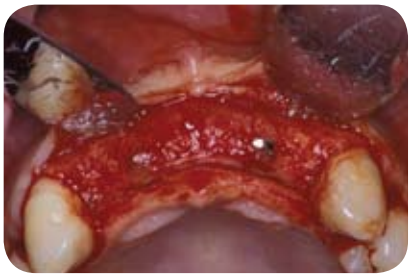

FIGURE 21A. Surgical re-entry at five months. Note the extensive vertical augmentation to the top of the bone screws.

FIGURE 21B. Surgical implant placement.

FIGURE 22A. Completed restoration with individual implant-supported crowns.

FIGURE 22B.

Conclusion

Socket preservation and augmentation procedures are increasing as dental implant restorations have become the treatment of choice, especially in the esthetic zone. Provisional restoration from an interim prosthesis can adversely

affect the result achieved from a grafting procedure. The purpose of this paper was to illustrate different grafting techniques and to provide a rationale for the use of different types of interim prosthesis. Communication between the restorative dentist and the surgeon is essential so that the restorative dentist is aware of the type of graft procedure to be performed. This will allow fabrication of the proper interim prosthesis and give the case the best prognosis for long-termed functional and esthetic success. ■■■■

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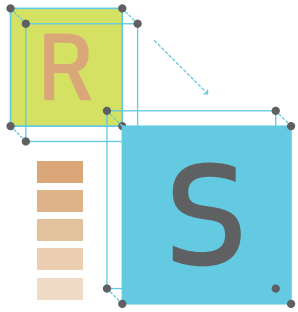

Transitioning Patients: Teeth to Implants

ARUN B. SHARMA, BDS, MSC; CRAIG Y. YONEMURA, DDS; DONALD A. CURTIS, DMD; AND FREDERICK C. FINZEN, DDS

ABSTRACT The transition of patients from a dentate state to an implant-supported restoration requires significant planning. Traditionally, protocols have included the extraction of teeth and interim use of a removable prosthesis. Newer protocols include approaches to decrease the period of time a patient is required to use a traditional denture. The authors' purpose is to outline options and provide clinical examples when transitioning patients from natural dentition to an implant-supported prosthesis.

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In treatment planning the restoration of an edentulous space, the use of dental implants should be considered. Implant-supported prostheses have a high rate of success, as reported by Adell et al., Zarb, and Symington.[1-3] In a multicenter study by Albrektsson in edentulous patients, the 10-year survival rates of such implants were 82 percent for the maxilla and 94 percent for the mandible.[4] Attard and Zarb reported 96 percent implant cumulative survival/success rates (CSR) for overdentures and 87 percent CSR for fixed bridges.[5,6] Ekelund et al. reported 99 percent CSR for implants supporting a fixed bridge in the edentulous mandible over a 20-year period.[7]

Implant-supported prostheses provide a number of advantages. In the edentulous patient, implants provide increased support, retention, and stability for prosthesis. The use of implants to restore dentitions has enabled the dentist to rehabilitate patients to a more normal masticatory function and an improved lifestyle.

Edentulous patients who present with concerns about function and comfort with their complete dentures are typically treated with a traditional protocol. Implants are placed and restored using a two-stage surgical protocol that requires the patients to continue using their existing dentures during the healing phase. Patients who present with an intact dentition with advanced periodontal disease or a dentition that has a poor restorative prognosis are usually treated with extractions and immediate dentures. Following a healing period, implants are placed using the two-stage surgical protocol similar to patients who presented in an edentulous state. In transitioning these patients to implant-supported restorations, it is often necessary to have patients use a removable prosthesis for up to nine months.

With current immediate-loading protocols, edentulous patients can avoid

the phase of using complete dentures after implant placement.[8-11] However; these immediate-loading protocols cannot be used for all patients who present with an intact dentition. The purpose of this paper is to present patients who were transitioned from an intact dentition to an implant-supported restoration and to discuss the rationale for the selected treatment sequence.

Patient No. 1

A 49-year-old-female presented to the authors' offices in January 2005, seeking comprehensive dental treatment. Her medical history was significant for a history of hepatitis B (noncarrier) and noninsulin-dependent diabetes mellitus, NIDDM. Her diabetes was under fair control, taking 500 mg metformin and 10 mg glyburide both b.i.d., and her most recent glycosylated hemoglobin was 7.4.

Her periodontium suffered from advanced attachment loss with each tooth having lost at least 6 mm (**FIGURE 1A**). Mobilities ranged from 1-3 and with all molars having Class III furcations with the exception of the maxillary second molars, which had fused roots. The radiographs clearly show the advanced horizontal, vertical, and circumferential defects. Calculus deposits were generalized, and tooth No. 14 had a hopeless prognosis from a periodontal, restorative, and endodontics perspective.

Given the advanced nature of the periodontal disease, and only fair metabolic control of the NIDDM, there was a limited possibility of maintaining the existing dentition. She desired predictability but also wanted to retain her teeth. Several detailed discussions were required before she understood that tooth retention and a predictable restoration were, in her case, mutually exclusive. Ultimately, she decided that predictability was her highest priority, so she accepted the plan of extraction of her dentition, insertion of immediate dentures, placement of implants, and restoration with fixed prostheses.

FIGURE 1A. Pretreatment panoramic radiograph.

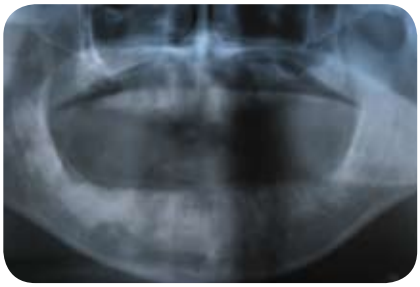

FIGURE 1B. Postextraction panoramic radiograph.

FIGURE 1C. Frontal view of provisional fixed partial dentures

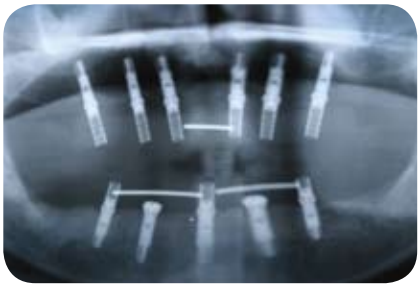

FIGURE 1D. Panoramic radiograph with provisional restoration.

The transition from fully dentate to edentulous arches was done in a traditional fashion. Removal of the posterior teeth, with the exception of the first premolars, was performed in June 2005. The ridges were allowed to heal for six months, impressions were made, and immediate dentures were fabricated. After a healing period (**FIGURE 1B**), in October 2006, six implant fixtures were placed in the maxilla. These were all 13 mm in length, and the most posterior on either side required osteotome sinus elevation for the apical 2 to 3 mm of the fixture. The mandible received three 15 mm fixtures between the mental foramen, and two 11.5 mm fixtures were placed posterior to the mental foramen on either side. None of the fixtures required bone augmentation in the coronal portions of the fixtures. Amoxicillin 500 mg t.i.d. was prescribed postoperatively for eight days. The postoperative period was uneventful, and healing abutments were placed in April 2007. In June, fixed provisional restorations (**FIGURES 1C-D**) were delivered in both arches.

As is the authors' standard protocol, definitive porcelain fused to metal restorations are not fabricated for at least six months. During the six months with the provisional restorations, both the patient and the provider have the opportunity to evaluate speech, esthetics, and the ability to maintain satisfactory oral hygiene.

Patient No. 2

A 49-year-old male patient presented with many defective restorations and extensive caries (**FIGURE 2A**). He was interested in implants and wanted to avoid a removable prosthesis if possible. After an extensive evaluation that included radiographs, diagnostic casts, and a full examination, a treatment plan was formulated. In the maxillary arch after caries removal, the treatment plan included conventional crowns and bridges. In the mandibular arch, the treatment plan the patient accepted involved extraction of all remaining teeth and an immediate complete denture. After a short heal-

FIGURE 2A. Pretreatment panoramic radiograph.

FIGURE 2B. Implant placement, standard and temporary.

FIGURE 2C. Provisionals.

FIGURE 2D. Mandibular provisional on implants.

FIGURE 2E. Completed treatment panoramic radiograph.

FIGURE 2F. Definitive restorations *(prosthodontic treatment by Tony Chammas, DDS).*

ing phase, six implants (**FIGURE 2B**) were placed following a two-stage surgical protocol. At the time of implant placement, six transitional implants (Dentatus Modular Transitional Implants, Dentatus USA Ltd., New York, N.Y.) were also placed to support an immediate-fixed provisional restoration (**FIGURE 2C**).

After second-stage surgery, a provisional restoration was delivered on the definitive implants and the transitional implants were removed (**FIGURE 2D**). Definitive prosthodontic treatment (**FIGURES 2E-F**) was then completed following the standard protocol at postgraduate prosthodontic program at the University of California, San Francisco.

The treatment selected for this patient allowed a transition from a fully dentate mandibular arch to an implant-supported fixed restoration in a period of nine months. Utilization of the transitional implants limited the use of a removable complete denture to two months. The treatment for this patient was completed before currently available immediate-loading protocols were routine therapy.

Patient No. 3

The patient was originally referred to a periodontal office in 1974 when she was 19 years old. Her medical and social history did not contribute to her periodontal condition. The pocket depths ranged from 4 mm to 6 mm in all areas, except the maxillary anterior segment, which had only 2 mm to 3 mm probing depths. There was 10 percent to 30 percent horizontal bone loss with superimposed shallow vertical and circumferential defects in multiple areas. The periodontal diagnosis in 1974 may have been juvenile periodontitis or rapidly progressive periodontitis, but the current terminology would assign the diagnosis of aggressive periodontitis.[12]

Pocket reduction was performed in 1975 and 1979 in the posterior sextants. A three-month recall/maintenance schedule was followed closely from 1975-1997 when one author accepted the responsibility for the patient. Between 1991-2003, operative procedures, fixed prosthodontics, endodontics, surgical endodontics, extracoronal splinting, and root amputations were performed. In 2004, the patient began having problems, mostly in the mandibular arch, with root caries, pain with normal functioning, and increasing mobility (**FIGURES 3A-B**). Because periodontal therapy began at such an early time in her life, she was aware that tooth loss was a distinct possibility for her. The discussion of implant therapy was thus initiated, but she wanted to avoid a removable interim prosthesis. Additionally, while she was aware that the maxillary arch would likely follow a similar fate, she was only able to restore the mandibular arch at that time.

Transitioning this patient to an implant-supported restoration involved two challenges: first transitioning a dentate mandibular arch to an edentulous, implant-supported dentition without a removable interim prosthesis; and second, transitioning each arch at different times, perhaps several years apart.

To transition the mandibular arch, it is critical to have adequate abutment teeth for a provisional fixed partial denture. The requirements for abutment teeth to support a provisional fixed partial denture are obviously different

from those for a definitive fixed partial denture because the provisional abutment teeth need to support the restoration for only months rather than years.

Nonetheless, provisional abutment teeth need to be distributed in a pattern that will accept normal masticatory forces for six to 12 months. In this case, the cuspids and second molars were prepared, the remaining teeth were extracted, and a 12-unit fixed provisional was fabricated and cemented (FIGURES 3C-D). The implants were placed in the areas of Nos. 19, 21, 23, 26, 28, and 30. Following second-stage surgery to uncover the implants, a fixture level impression was made and a provisional implant supported restoration was fabricated (FIGURE 3E). The provisional was delivered when the provisional abutment teeth were extracted (FIGURE 3F). The definitive porcelain fused to metal restoration was delivered approximately nine months later following complete healing of the extraction sites (FIGURES 3G-H).

Because the maxillary arch will be restored in the future, the mandibular arch was restored to an ideal occlusal plane. The maxillary teeth were adjusted to accommodate the mandibular restoration.

FIGURE 3A. Pretreatment frontal view.

FIGURE 3B. Pretreatment panoramic radiograph.

FIGURE 3C. Prepared teeth for provisional.

FIGURE 3D. Provisional fixed partial denture on four abutment teeth.

FIGURE 3E. Fixture level impression copings.

FIGURE 3F. Provisional fixed partial denture on implants after extraction of four teeth.

FIGURE 3G. Definitive mandibular fixed partial denture.

FIGURE 3H. Panoramic radiograph of completed treatment.

Patient No. 4

A 60-year-old female patient presented with the desire to have her maxillary arch restored with a fixed implant restoration. She had used a tooth-supported removable partial denture for many years, but now many of the abutment teeth were failing. There was inadequate bone height and width for placement of a sufficient number of implants to support a fixed restoration. Three-dimensional radiographs demonstrated the need for ridge augmentation in both height and width. After many joint discussions on the treatment options, the following was the selected treatment sequence: (1) extraction of teeth Nos. 3, 6, and 14, with addition of these teeth to the existing removable partial denture; (2) after healing from the extractions (FIGURE 4A) preparing teeth Nos. 2, 8, 9, and 15 for a provisional fixed partial denture (FIGURE 4B).

In order to increase ridge width, onlay grafts were planned for the areas of teeth Nos. 4, 5, 6, 11, 12, and 13. To avoid

FIGURE 4A. Pretreatment.

FIGURE 4B. Maxillary provisional on teeth Nos. 2, 8, 9, and 15.

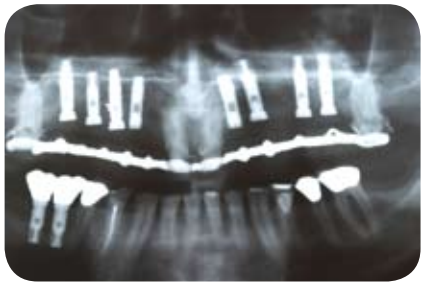

FIGURE 4C. Panoramic radiograph of metal reinforced provisional during implant integration phase.

FIGURE 4D. Maxillary provisional on implants.

FIGURE 4E. Definitive maxillary fixed partial denture.

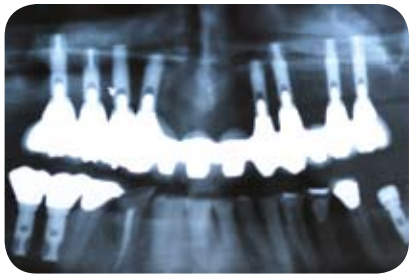

FIGURE 4F. Panoramic radiograph of completed treatment

a tissue-borne removable prosthesis in the area of the bone graft, the area was restored with a provisional fixed partial denture; (3), bone graft (Dr. Pham) to both maxillary sinuses and right and left residual alveolar ridges; (4) placement of eight implants (Dr. Pham) (**FIGURE 4C**); (5) second-stage surgery to uncover implants and fixture level impression to fabricate provisional implant supported prosthesis; (6) extraction of teeth Nos. 2, 8, 9, and 15, and insertion of provisional implant-supported fixed partial denture (**FIGURE 4D**); and (7), fabrication of a definitive porcelain fused to metal-fixed partial denture (**FIGURES 4E-F**).

Conclusion

There are many options available today that will allow a practitioner to transition patients from the dentate state to implant-supported restorations. Some of these options will eliminate the use of a removable prosthesis. In this paper using clinical examples of four patients, the authors have presented the treatment sequence and the rationale for the selection. Immediate loading is an additional method that is available today, but not all patients who present with an existing dentition are appropriate candidates for the immediate-loading protocol. ■■■■

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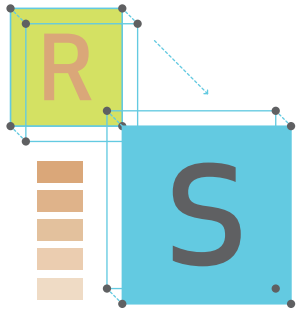

The Use of Dental Implants to Improve Quality of Life for Edentulous Patients

DONALD A. CURTIS, DMD; ARUN B. SHARMA, BDS, MSC; AND FREDERICK C. FINZEN, DDS

ABSTRACT The number of edentulous patients in the United States requiring prosthodontic care is projected to increase in the next 20 years. Awareness of the restorative options to manage edentulous patients will become increasingly important to all dental practitioners. The authors' purpose is to sensitize the reader to the functional deficit in the completely edentulous patient and how restorative approaches with implants can improve patient reports of function and quality of life.

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One-third of Americans over the age of 65 are edentulous and the number of patients likely to need prosthodontic care in the next 20 years is projected to increase significantly.[1,2] The increasing size of this cohort has implications to social policy, dental education, and patient treatment. As clinicians, it is important to be aware of functional limitations and restorative options for edentulous patients. Missing dentition that is not replaced with a prosthesis has been shown to result in a reduced quality of life comparable with the effect of cancer or renal disease on physical well-being scales.[3] An especially relevant area is the mandibular arch because a lower denture often represents a significant compromise in function compared to natural dentition.

Masticatory performance of people wearing complete dentures is less than 20 percent of those with natural dentition.[4,5] More patients report problems with the lower denture than the upper denture, and the most frequent reasons for dissatisfaction are pain, an unstable denture, and difficulties eating.[6] Functional loss is obviously related to the lack of support and stability afforded by dentition, but it is also influenced by diminished salivary flow, decreased tongue motor control, reduced bite force, and diminished oral sensory function.[7-10] In a study of 30 edentulous elderly patients, Ikebe et al. reported that 67 percent of the variation in masticatory performance could be explained by variation in salivary flow, bite force, and oral sensory function.[8] This is not surprising when one considers

FIGURE 1A. When an edentulous patient is not a candidate for implants yet has significant concerns with their existing dentures, the authors have found using a gold base for the lower denture improves patient reports of satisfaction.

FIGURE 1B. Although this is anecdotal evidence, the weight of the gold base has been found to be helpful in improving perceived retention of the lower denture.

that all sensory abilities (vision, auditory, tactile, chemosensory, etc.) start to diminish after the age of 25, and this has an impact on oral function independent of tooth loss in the dentate individual and synergistically in the edentulous patient.

It is difficult to predict how well an edentulous patient will function based solely on anatomic findings. For example, a patient with sufficient ridge height may not function to the expected level based on anatomic findings. Although studies have shown that masticatory performance of denture patients significantly diminishes, patient-related factors such as ridge height and clinical factors, such as technical quality of dentures, only moderately correlate to patient levels of satisfaction.[4,5,11–15] Of course this does not mean that technical excellence does not play a role in optimizing care for patients wearing complete dentures, just that many biological and psychological factors also affect patient satisfaction. For this reason, a complete history that includes questions about levels of masticatory function and impact of existing dentures on quality of life becomes important when treatment planning the edentulous patient for restorative care.

There are many options for restoring the mandibular arch in the edentulous patient. These include the fabricating a new conventional denture, IOD, an implant overdenture, using two or four implants with either a bar and clip or ball attachments, a completely implant-supported removable prosthesis or a fixed prosthesis.

The authors will be reviewing the relevant dental literature and present related clinical examples of prosthetic approaches when treating the edentulous patient. An emphasis will be that planning the correct treatment for the correct reasons requires sensitivity to the psychosocial implications of edentulism, understanding the efficacy of various treatment options, and being skilled in the technical aspects of treatment.

New Dentures

So what can a patient and clinician expect from a new denture? A new denture has been shown to lead to improvements in patient reports of overall satisfaction; most often measurable improvements in esthetics, comfort, and speech.[16] However, new conventional dentures will often not improve functional outcomes.[16] In reporting what foods patients were able to eat before and after a new conventional dentures, Awad et al. reported no improvement in ease of chewing carrots, apple, cheese, sausage, bread, or lettuce.[16] In some situations, new dentures have actually resulted in an overall decrease in patient satisfaction, usually when patients sought implant treatment but had to settle for conventional dentures.[11]

The functional deficit of denture wearers is more problematic in older patients and in patients who self-select as needing implants[6,17] (**FIGURE 1**). Smith et al. reported that in elderly denture patients, 25 percent reported pain when chewing, and 41 percent needed more time for chewing.[17] This may be because of age-related physiologic changes such as decreased motor tongue control, decreased biting force, or medication-induced xerostomia. The significance is that the long-term denture patient who currently functions at an acceptable level may, with age, need to be considered for an IOD because function has decreased. Additionally, patients who present with the request for implants often report more psychosocial and functional problems and are harder to satisfy than patients who request conventional dentures.[6,18]

The ability of edentulous patients to tolerate complete dentures is variable and unpredictable. In some situations, patients adapt well to a conventional denture and such patients may report relatively high levels of function as measured by standardized measures.[16,19] Other patients will not have high levels of masticatory function, but this functional deficit does not adversely impact quality of life reports.[20] Therefore, it should not automatically be assumed all edentulous patients need implants. What is important is a comprehensive dental history that includes questions of function and quality of life measures by asking patients what foods they are capable of eating and if current levels of function adversely impacts daily living.

A simple food scale that has been used by the authors lists food in increasing levels of difficulty from soft chewable foods like macaroni, dry bread and crackers, carrots and celery, meats, and, finally, peanuts, as the most difficult to chew for most individuals.[21] A more sophisticated measure of the impact of edentulism on oral health can be gathered by using the Oral Health Impact Profile, OHIP, a 49-item questionnaire.[22,23] Although the

FIGURE 2A. The use of two implants.

FIGURE 2B. A. connecting bar.

FIGURE 2C. A clip. If two clips are desired the implants should be at least 12 mm apart and a metal harder than 220 Knopps hardness for fabrication of the bar because wear of the bar can occur over extended periods. Some authors prefer plastic clips because of ease of replacement while others prefer metal clips, which the authors have found are often more durable.

FIGURE 3A. When using four anterior implants with an attachment off the posterior there is increased support and retention compared to the two implant IOD.

FIGURE 3B. However, if implants can be placed posterior to the mental foramen there is increased support (e.g., **FIGURE 5**) and comfort, compared to four anterior implants.

OHIP has mostly been used in research, it is applicable to clinical situations to identify the subtle influences edentulism has on patient reports of quality of life.

Two or Four Implants and a Bar

What can the patient and clinician expect from an IOD using a bar and clip? There are a number of very good studies which compare IOD to conventional dentures with measured outcomes such as patient function, degree of satisfaction, and impact on quality of life.[6,11,16,20,24] The IOD bar/clip prosthesis can be expected to result in higher patient satisfaction in the areas of comfort, stability, and ability to chew.[20,25] Additionally, functional outcomes show significant improvements in the variety of food, particularly hard food, that the patient is able to comfortably masticate.[11,16] In a study of 60 edentulous subjects comparing those wearing conventional dentures to mandibular IOD, Awad et al. showed that the IOD patients were better able to eat carrots, apple, cheese, bread, and sausage.[16]

When planning to place two interforaminal implants, it is important to have sufficient interocclusal space, at least 12 mm between implants and adequate space anterior to the bar for setting denture teeth (**FIGURE 2**). The position of the lower implants can be more confidently communicated to the surgeon by completing a denture set-up prior to implant placement. It is also important to not only inform the patient of the anticipated benefits, but also of the limitations to this option. According to Allen and McMillan, the bar, clip overdenture approach resulted in a significantly improved level of function and improved quality of life measurements compared to conventional dentures, yet 30 percent to 50 percent of the patients wearing an IOD bar and clip still avoided eating foods such as carrots and apples.[11]

The comparison of four mandibular interforaminal implants rather than two has been evaluated by one author and it has not been shown to lead to improvement in patient reports of satisfaction.[26]

However, Geertman et al. compared four transmandibular implants to two endosseous implants and comparing different implant systems may not be equivalent. The authors of this paper suggest that four interforaminal implants offers some advantage over two implants, especially for patients who seek more retention and support of the lower IOD. An example of a patient treated with four implants is seen in **FIGURE 3**.

Two Implants and Attachments

What can the clinician and patient expect from an IOD with two attachments? Many different types of attachments have been used for anchorage to implants. Some of the older attachments are well studied but not currently available while some of the newer attachments look promising, but have not been rigorously compared to the bar and clip that the authors consider the standard (**FIGURE 4**).

If the outcome measured is initial patient satisfaction then there is probably very little difference between ball attachments, magnets, ERA attachments, or Hader bars.[24,27-29] However, most of the studies that have looked at longer-term outcomes reported that the number of adjustments and repairs with ball attachments was significantly higher than with a bar and clip.[30] In a study of 100 patients studied over a three-year period,

Walton determined ball attachments (Nobel Biocare, Yorba Buena, Calif.) were three times more likely than the bar and clip to need repairs and patients rated the bar and clip far more successful.[30] A strong predictor of favorable patient satisfaction has been shown to be retention of the prosthesis and when an attachment is not working properly patient concern is understandable.[31]

The advantages of ball attachments compared to a bar and clip are that they are less expensive, require less chairtime, less technical expertise, and will probably provide the same initial level of patient satisfaction. However, when implants are malpositioned or excessively divergent, a bar and clip will often facilitate a better functional and esthetic result than attachments. The authors are familiar with some of the newer attachments available (Locator, Zest Corp.) and the reaction is moderately favorable. However, since there are no randomized clinical trials comparing the locator attachment to the bar and clip, the authors' tendency is to recommend a bar and clip when using two implants in the anterior mandible.

FIGURE 4A. Clinical example of an IOD using Locator (Zest Corp.) attachments.

FIGURE 4B. Locator attachments are less expensive than a bar and clip, but few long-term studies have compared bar clip IOD to Locator attachments.

FIGURE 5A. This is an example of a CAD/CAM milled bar, an alternative to the traditional metal casting process. In this example, a significant anterior/posterior spread was created so the denture was entirely implant-supported.

FIGURE 5B. A metal housing was incorporated into the denture base.

FIGURE 5C. This incorporation was done to improve fracture resistance.

FIGURE 5D. The final prosthesis is shown.

Fully Implant-supported Fixed and Removable Options

Having implants placed posterior to the mental foramen allows for an entirely implant-supported prosthesis that affords a more comfortable and stable prosthesis than possible from two anterior implants (**FIGURE 5**). It is important to remember that pain is often the chief concern and limiting factor in wearing conventional dentures. Two interforaminal implants offer some support but the prosthesis is implant- and tissue-supported. When additional implants can be placed posterior to the mental foramen significant improvements in support, function, and comfort is possible. Because placement of implants can help with the preservation of bone, it is often advantageous to the patient to have posterior implants.[32] In young edentulous patients where expected resorption of posterior bone is likely to occur, the authors will often treatment plan implants before the anticipated bone loss makes implant placement more difficult. When implants can be placed posterior to the mental foramen and a completely implant-supported prosthesis can be considered, most of the studies have shown very little difference when comparing a fixed vs. removable implant-supported prosthesis.[6,33,34]

In a randomized crossover trial, Feine et al. determined most patients reported that a fixed prosthesis provided better stability and chewing ability than an implant-supported removable prosthesis; however, patients who valued aesthetics and cleaning ability were generally more satisfied with an implant-supported removable prosthesis.[33] Feine et al. also showed that a fixed prosthesis enabled the

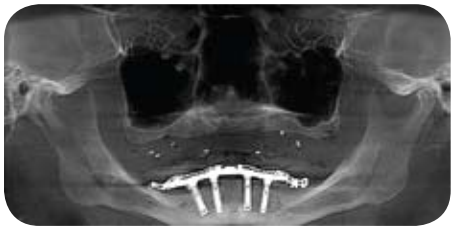

FIGURE 6A. The patient presented with a mandibular implant overdenture but complained about maxillary denture instability. Because of a low sinus, an "All-on-4" approach was planned.

FIGURE 6B. Radiograph of the patient with maxillary implants positioned such that the two anterior implants were vertically aligned and the posterior implants inclined to the posterior consistent with the "All-on-4" protocol.

patient to eat harder food such as carrots, apples, and sausage, but that patients over the age of 50 tended to prefer the implant-supported removable prosthesis.

When there is less than 10 mm to 12 mm of interocclusal space, sometimes a fixed prosthesis will be necessary. For an IOD-supported with a long bar, approximately 10 mm to 12 mm of vertical space is required for the space of the bar, clips, acrylic resin, and denture teeth. When considering a long bar implant-supported removable prosthesis, an additional consideration is cost. The additional cost of the longer bar, cast housing in the denture base, more restorative implant components, and increased chairtime can dramatically increase fabrication costs. The authors have found that a metal frame is required for strength in approximately 50 percent of the two-implant IOD prosthesis, but is recommended for all prosthesis that are entirely implant-supported. Further, the cost of a fixed prosthesis is, on average, significantly more expensive than the cost of a long bar removable prosthetic treatment.

All-on-4 Concept

The use of four implants to support a fixed complete denture has been recently advocated and evaluated.[35] This protocol involves using computer-guided surgery for the placement of four implants: two implants aligned in the edentulous anterior and two implants angled posteriorly so that anatomic barriers such as the maxillary sinus or inferior alveolar nerve can be avoided. The advantages of angled posterior implants are that longer implants can be used, procedures such a sinus lift can be avoided, and the length of a posterior cantilever can often be decreased. This protocol requires that the patient have an anterior vertical opening of at least 50 mm for placement of angled posterior implants. Additionally, the protocol requires that the implants be splinted and allows for immediate loading and function. The protocol has shown success rates of more than 97 percent but requires additional training and coordination of care.[35] **FIGURE 6** shows an example of implants added at an angle in preparation for a maxillary immediate fixed denture.

Conclusions

Implants have revolutionized restorative dentistry and have afforded many benefits for patient care. In the management of the edentulous patient, implants offer the potential for significantly improved function, and enhanced quality of life. The contemporary practitioner should be able to carefully assess the patients' current status and desires, appropriately discuss the treatment options with or without dental implants, and be skilled in the technical procedures required for prosthesis fabrication. ■■■■

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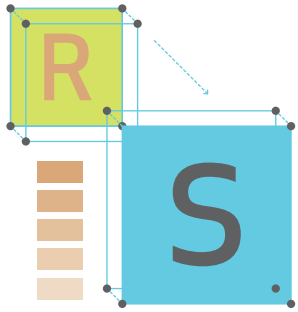

Narrow Diameter Implants for Mandibular Denture Retention

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ABSTRACT Narrow diameter implants are a lower cost alternative to conventional implants and are used to retain mandibular dentures. The experiences at a dental school predoctoral clinic are reviewed. The cumulative success rate for 626 fixtures placed in a six-year period is 92.6 percent with high patient satisfaction. Narrow diameter implants are a useful adjunct in the long-term management of edentulous patients.

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In 2002, an international symposium at McGill University concluded that a conventional denture was no longer the most appropriate option for restoring the edentulous mandible and that the two-implant retained overdenture should become the first choice prosthodontic treatment.[1] While the McGill consensus summarized numerous randomized controlled trials and longitudinal clinical studies as overwhelming evidence for preferring implant-retained dentures, the issues of affordability and access to this level of care were unresolved. In the United States, coverage of dental implants by third parties is in its infancy and is nonexistent in the Medicaid system. Edentulism in this country is strongly associated with low income, and most edentulous patients cannot afford the high cost of implant dentistry.[2]

The use of narrow diameter or mini-implants is potentially one of the solutions to the inaffordability dilemma. They are endosseous implants made of titanium alloy and less than 3 mm in diameter. They were introduced commercially to the dental profession in the 1990s and were first used for transitional prosthesis support.[3,4]

Recently, manufacturers have marketed them widely to the profession and patients as lower cost, less invasive, and technically easier alternatives to conventional implants. They are now used in a variety of applications, including orthodontic anchorage, single and multiple tooth fixed replacement, bridge repair, and removable prosthesis retention.[5-10] The small diameter of each fixture (1.8 mm to 2.4 mm), as well as the reduced surgical and prosthetic armamentarium, result in lower overhead and fees compared with conventional implants. A patient can receive a mandibular overdenture retained by four narrow diam-

FIGURE 1A. Four sites were marked on ridge crest tissue of anterior mandible and pilot osteotomies will be created through the tissue. The drill (Atlas Implant, Dentatus USA, New York, N.Y.) is used at slow rotational speed with copious sterile irrigant, to half the length of the proposed implant length if the bone is soft or to the full length of the implant length if the bone is resistant.

FIGURE 1B. Four Atlas implants have been placed in the anterior mandible. Note the lack of tissue trauma.

FIGURE 1C. Postoperative panoramic radiograph of 14 mm length Atlas implants.

FIGURE 2A. Preoperative view of periodontally compromised mandibular canines.

FIGURE 2B. The mandibular canines have been extracted and four 15 mm- length MDI collared implants (IMTEC Corp., Ardmore, Okla.) have been placed through the soft tissue at sites No. 21, 23, 26, and 28.

FIGURE 2C. The patient's original transitional partial denture was converted to an immediate complete denture and this was retrofitted over the implants at the conclusion of the surgery. The patient left the clinic with function and esthetics fully restored.

eter implants (**FIGURE 1**) for less than half the cost of the standard treatment with two conventional implants.

Additional benefits of narrow implants are the ability to place them in horizontally narrow sites (4 mm of bone required), minimally invasive surgical technique, and the ability to load the implants immediately.

A contentious issue with narrow diameter implants is the lack of evidence for clinical suitability and success, particularly the absence of objective long-term and prospective comparative studies. It has been shown that narrow diameter implants osseointegrate to the same extent as conventional implants, and success rates reported for limited patient cohorts over brief service periods have been favorable (93 percent to 98 percent).[11-13]

A multiclinic study of 1,029 mini-implants used for mandibular denture retention, with service range of five months to eight years, had an overall success rate of 91.2 percent, and 89 percent for fixtures in place for at least five years.[14]

Another study reported the long-term results for 2,514 mini implants placed in a single office over a five-year period and subjected to a spectrum of prosthetic anchorage in both jaws: single crowns, fixed partial dentures, removable partial dentures and complete dentures; the overall success rate was 94.2 percent.[15] The encouraging results of both these long-term studies are restrained by the disclosure statements that the lead authors had commercial interests in the products cited in the papers.

The University of the Pacific Arthur A. Dugoni School of Dentistry has an edentulous patient base typical of urban areas in the United States. Many of these patients struggle with unstable mandibular dentures but are unable to afford the undergraduate clinic's basic two-implant overdenture protocol that has been in place since 1982 and reliably improves oral function and patient self-confidence. Narrow diameter implants are part of the curriculum at Pacific and have been offered as an alternative and less costly treatment for our patients with edentulous mandibles since 2001.

In the last six years, more than 150 operators, most of them senior dental students with close faculty supervision, have placed 626 narrow diameter implants, and 37 percent of these were inserted at the time of extraction and

FIGURE 3A. This patient complained that both remaining implants were painful and loose. Four MDI collared implants had been placed at a private office 12 months previously, and two had been lost already. Both implants have total exposure of the collar (normally collars are completely embedded in soft tissue).

FIGURE 3B. Panoramic radiograph showed lack of bone around implant at site No. 20, with dangerous proximity to the mental foramen (fortunately, the patient had no paresthesia). The implant at site No. 24 demonstrated significant funneling in the bone. Both implants were removed.

immediate denture placement (**FIGURE 2**). Forty-six implants have been lost, due to loosening, chronic pain, or infection, for an overall success rate of 92.6 percent. The protocol of placing four fixtures intraforaminally provided 1 to 3 pounds of resistance to vertical displacement of the denture, and substantially reduced the tendency of the denture to wander laterally during function. The o-ring retainer (MDI system, IMTEC Corporation, Ardmore, Okla.) or soft liner (Atlas system, Dentatus USA, Ltd., New York, N.Y.) permitted the denture to be entirely supported by soft tissue. If the implants were placed without raising a soft tissue flap, patients noted the lack of surgical drama and generally, the healing interval was mild. When a conventional denture was retrofitted to the implants, patient appreciation of the improvement in denture comfort and function was universal.

The word-of-mouth referral of new patients by satisfied implant overdenture patients has been a notable aftereffect of this program at Pacific. Another significant outcome of the narrow diameter overdenture program for students at Pacific was the learning and practice of distributive justice, which is specifically, in this case, the allocation of implant resources and effective procedures among a diverse edentulous population.

The experiences at Pacific with narrow diameter implants reflected the learning curve associated with the development of a predictable protocol for a new elective surgical/prosthetic treatment. Exclusion criteria for patients were conservative: severe or recent cardiac pathology, severe hypertension, uncontrolled diabetes, or bleeding disorder, AIDS, any condition that seriously compromised bone healing potential or autoimmune response, intravenous bisphosphonates, heavy smoking, personality disorder or psychosis, substance abuse, and physician veto.

In addition, patients with Class IV edentulous mandibles (American College of Prosthodontists classification, indicating less than 11 mm of vertical bone height or absent clinical ridge) were excluded. Presurgical planning was accomplished with a study model and a panoramic radiograph.

If available, the existing denture was used as a general guide for artificial tooth position, location of the bulk of the denture base and for occlusal plane orientation. As a cost control measure, CT scans and laboratory fabricated surgical stents were not used on a routine basis.

Procedures to retrofit and reline existing dentures were more stringent than normally encountered in denture prosthetics, due to the unforgiving nature of implant attachments. Post-treatment swelling, surgical pain, and denture sore spots were encountered routinely. Three patients had severe local postsurgical swelling that did not respond to antibiotics, and all fixtures were removed within one month. The worst surgical complication was a chronic osteomyelitis around one narrow diameter implant, resulting in extravagant bone loss and delayed healing. There have been no paresthesias, as would be expected, because no implants have been placed in the posterior mandible, and all implants were placed at least 5 mm medial to the radiographic mental foramina.

The Implant Clinic at Pacific has had experiences other than treating its own patients. Multiple patients with narrow diameter implant problems and failures who were referred to Pacific from local communities have been evaluated and treated. Common issues included atypical implant location, extreme divergence of implant axes, infection, implant rejection, and poor prosthesis fit.

Also, the authors have received reports from other parts of the United States regarding inappropriate treatment with these implants (**FIGURE 2**). Egregious failures have been published.[16] Dentists who are accustomed to a disciplined approach to achieve success with conventional implants are dismayed by these instances of poor planning, execution, and follow-up.

To make matters worse in this field, aggressive marketing strategies feature patient-targeted infomercials and Web-based advertising; dentists are enticed with promises of enhanced profitability; and small diameter implants have become the organizational axis for profit-dominant denture franchises. This business-first energy obscures the message that narrow diameter implants can be a useful adjunct to dentistry and a benefit to many denture patients. The usual high standards of dedication to scientific inquiry and excellence in clinical practice are required of the professional and manufacturing communities before narrow diameter implants will be wholly accepted in dentistry.

Conclusions

Narrow diameter implants have been used successfully to provide retention for mandibular overdentures. More long-term studies are needed to compare narrow and conventional diameter implant outcomes, including honest analysis of the problem patterns with narrow diameter variety. ■■■■

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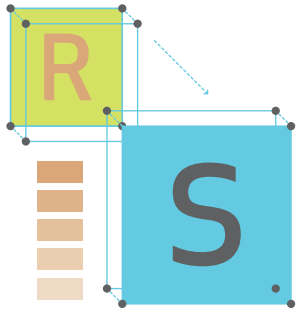

Radiologic Techniques Using CBCT and 3-D Treatment Planning for Implant Placement

JEROME N. PECK, DLXT, AND GREGORY J. CONTE, DMD, MS

ABSTRACT Determining the placement of dental implants can be greatly improved through the use of medical CT or dental cone beam computed tomography. As the use of CBCT technology has become more accessible, 3-D treatment programs have evolved considerably. Two cases will be reviewed to illustrate how model-based CBCT treatment planning and 3-D multiplane treatment programs can assist with the pretreatment evaluation and decision-making process for the complex placement of implants.

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DISCLOSURE

Jerome N. Peck is owner and chief executive officer of both C-Dental X-Ray, Inc., and Rapident Surgical Guides, Inc. Rapident Surgical Guides is the exclusive California distributor for iDent software and manufacturer of iDent surgical guides.

In May 2001, CBCT imaging for dentistry was introduced to the United States by QR srl of Verona, Italy, the manufacturer of the NewTom. Since then, several different hardware and software manufacturers have developed CBCT machines and 3-D software packages, which have significantly contributed to the advancement and adoption of both technologies.

Prior to the advent of CBCT, medical CT was not embraced in dentistry because of its high cost and the high radiation dose to the patient.[1,2] The average cost for medical CT in 2000 was $750 per arch. Additionally, the high cost of the medical CT examinations directly affected the adoption of virtual 3-D treatment planning programs. Today, with an average cost of $400 for both arches and radiation levels that are comparable to an orthopanograph, CBCT is experiencing enormous success.[1] Furthermore, the acceptance of CBCT has assisted the growth of many 3-D treatment planning companies.

The potential treatment complications with the placement of implants are well documented and one of the most important steps is obtaining appropriate radiographs. The complex task of determining the proper placement of implants prior to surgery is an essential one. "Two dimensional images such as orthopanographs and periapical films have inherent shape and size distortion along with changes in magnification."[3]

Utilization of CBCT clearly illustrates the true 3-D shape and size of all anatomical structures. By combining CBCT and 3-D treatment planning, implants are being placed with ideal prosthetic results.

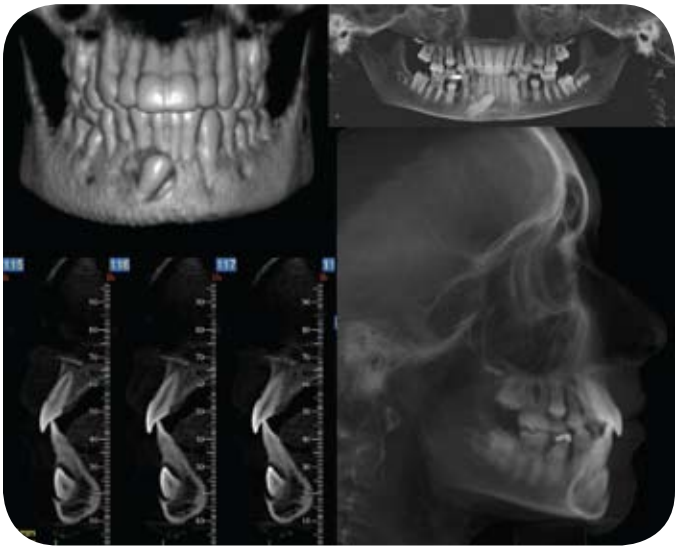

FIGURE 1. Three-dimensional view, panoramic, lateral cephalometric, and anterior cross sections illustrating capability of CBCT and voxel opacity necessary to render these different images. *(Images created in Dolphin 3D and NewTom software, C-Dental X-Ray, Inc.)*

FIGURE 2. Axial, panoramic, and cross-sectional views of a CBCT scan. *(Images created in NewTom software, C-Dental X-Ray, Inc.)*

Determining the Accuracy of CBCT

The error factor in CBCT is determined by the size of the voxel.

Voxel, short for volume pixel, is the smallest distinguishable box-shaped part of a three-dimensional image. Voxelization is the process of adding depth to an image using a set of cross-sectional images known as a volumetric dataset. The dataset is processed when slices are stacked in computer memory based on interpixal and interslice distances to accurately reflect the real-world sampled volume. Now that the data set exists as a solid block of data, the pixels in each slice have taken on volume and are now voxels. For a true 3-D image, voxels must undergo opacity transformation. Opacity transformation gives voxels different opacity values. This is important when it is crucial to expose interior details of an image that otherwise would be hidden by darker more opaque outside-layer voxels.[3]

The lateral cephalometric in (**FIGURE 1**) is an ideal example of voxels that have changed their opacity, thus allowing the visualization of sella-turcia. The size of a voxel directly represents the detail of an image, the smaller the voxel, the better the resolution.

DICOM Standards

CT scanners used in medical CT as well as the dental CBCT scanners create their own proprietary file formats. Today's manufacturers of CBCT machines comply with the 3.0 DICOM (digital information communication for medicine) standards; they export their proprietary files into the DICOM standard.

DICOM is the industry standard for transferal of radiological images and other medical information between computers. Patterned after the Open System Interconnection of the International Standards Organization, DICOM enables digital communication between diagnostic and therapeutic equipment and systems from various manufacturers.[4]

CBCT programs allow the clinician to pinpoint, visualize, and define anatomical structures. Subsequently, the DICOM protocol allows the transfer of CBCT files into third-party 3-D treatment programs written specifically for dentistry. The ability to share DICOM files improves communication between dentists in every modality of dentistry. Images are stored electronically further reducing the necessity for additional patient exposure. It should also be noted: one CBCT scan provides information that can be used by every modality in dentistry. Images in **FIGURE 1** illustrate how one volume can be used by multiple 3-D programs, the lateral cephalometric and orthopanograph were processed using Dolphin 3-D. The cross-sectional and 3-D model images were processed using the NewTom software.

CBCT Imaging for Implants

Implant placement through the use of CT and CBCT has dramatically helped to improve the placement of implants. In 2001, the American Association of Maxillofacial Radiologists recommended that a CBCT scan be obtained for the placement dental implants.[5] But, CBCT alone does not tell the entire story. **FIGURE 2** clearly illustrates all anatomical boundaries of the mandible. The software used to create this image utilizes tools that accurately mark the delineation of the nerve and provide 1:1 images, allowing for accurate measurements. But, many surgeons require additional information. They desire the ability to integrate the CBCT data into implant surgery. Using CBCT without any type of radiographic markers or a 3-D program that places implants into the study can be as analo-

3A.

3B.

FIGURE 3. Intraoral photographs, buccal and occlusal views of lower left molar.

FIGURE 4. The model is prepared from a vacuform of the diagnostic wax up using a standard 3/32 drill bit. A 16-mm rod of the same diameter is inserted into the cast.

gous to arriving at a fork in the road with no directional signs leaving the surgeon unable to understand the true treatment plan.

CBCT and Model-based Treatment Plans

Model-based treatment planning with radiographic markers is a successful technique used to merge CBCT images into the surgery and requires absolutely no software. This technique can be used for single tooth (**FIGURE 3**) or multiple tooth replacement, and will give the clinician valuable information for treatment planning. Several modifications of the original technique have been developed and published.[6] In brief, diagnostic casts and a wax-up of the proposed site are obtained by the clinician. A vacuform of the wax up is made with thin acrylic material (0.20 thickness) and the site is prepared with a 3/32 standard drill bit. A 16-mm rod with the same diameter as the 3/32 drill bit is inserted into the cast and a second vacuform is pulled over the cast with the 0.20 material (**FIGURE 4**).

The template is removed from the cast, trimmed, and the tube is filled with radiopaque material (gutta percha or a smaller metal rod)(**FIGURE 5**). The marker needs to allow the patient to have complete occlusion without distortion in order for the scan to have diagnostic value. The image would show incorrect emergence angle and placement position for the implant if the patient occludes heavily on the marker. A CBCT scan is performed with the patient wearing the radiographic guide; images are then evaluated to determine bone height, width of the mandible and the position of

FIGURE 5. A second vacuform is completed over the small diameter rod. The vacuform is removed, trimmed, and the diameter is filled with gutta percha for radiographic analysis.

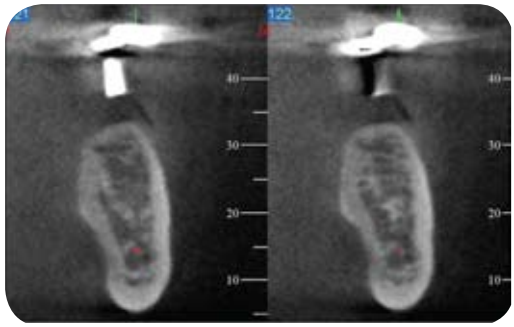

FIGURE 6. NewTom volumetric scan of patient with the radiographic template (sagittal view). The template indicates proper angulation and direction for implant placement. Note the excellent bone volume and position of the mandibular canal.

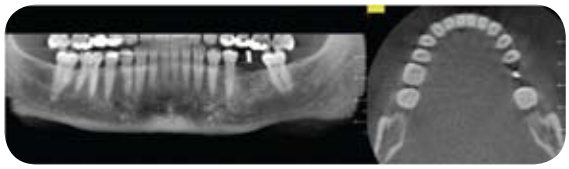

FIGURE 7. NewTom volumetric scan of patient with the radiographic template (panoramic and axial view).

FIGURE 8. Following radiographic confirmation, the cast is prepared for fabrication of the surgical stent. The prepared cast is placed on a surveying table and the initial preparation is enlarged to 9/16 with a drill press. A larger diameter rod is inserted into the cast following enlargement of the preparation with the 9/16 drill bit. A template using 0.060 acrylic material is pulled over the cast with a vacuform.

FIGURE 9. The completed surgical stent. The diameter of the preparation corresponds to the final diameter of the implant to be inserted. Surgical sleeves are utilized for stages of drilling.

FIGURE 10. The completed surgical stent. The diameter of the preparation corresponds to the final diameter of the implant to be inserted. Surgical sleeves are utilized for stages of drilling.

FIGURE 11. Clinical presentation for the radiographic images above. The lower left molar (No. 19) will be replaced with an implant restoration. The surgical stent is used for proper implant placement. The photo shows the implant in the correct position as confirmed by the surgical stent. Clinical and radiographic appearance of final implant supported restoration replacing the lower left molar.

FIGURE 12. Diagnostic wax-up. *(Image provided by Implant Logic.)*

FIGURE 13. Radiographic guide with three reference markers. *(Image provided by Implant Logic.)*

FIGURE 14. Implant Logic computerized milling machine used to manufacture surgical guides. *(Image provided by Implant Logic.)*

FIGURE 15. Implant logic Pilot Guide and Compu-Guide. *(Image provided by Implant Logic.)*

the nerve canal (**FIGURES 6 AND 7**). Measurements are performed to determine the length of the implant and to make any changes in angulation or position for the implant that may be necessary prior to the fabrication of the surgical stent. When the necessary corrections have been made, the cast is brought back to the surveyor, the site is enlarged using a 9/16 drill bit in the drill press. A large-diameter rod with the same diameter as the 9/16 drill bit is inserted into the cast and a vacuform is pulled using 0.60 or 0.80 acrylic material. The thicker material is needed for the fabrication of a rigid surgical stent (**FIGURES 8, 9 AND 10**). A typical clinical case from a model-based treatment plan is shown in **FIGURE 11**.

The Virtual Patient

The limitations of model-based treatment planning has become abundantly clear when directly compared with virtual treatment planning, especially when multiple implants are being placed. Today's clinicians have a number of 3-D treatment planning programs to choose from. For this article, the authors reviewed four of the most commonly used 3-D programs: Materialise's Simplant, Nobel Biocare's Procera, Implant Logic's VIP and iDent's Scan2Guide. Each system has its own protocol and provides the clinician with highly accurate surgical guides. Following the exact protocol of each individual system is essential in the fabrication of surgical guides. Lack of attention to the specific protocols in imaging or the manufacturing of a radiographic guide will result in the need for repeat CBCT scans, thus unnecessary X-ray exposure and ill-fitting surgical guides.

Five-axis Milling and Virtual Model Treatment Planning

Of the four 3-D programs referenced, only Implant Logic utilizes a five-axis milling technique for manufacturing of its surgical guide. Called Compu-Guide, manufacturing requires the doctor to send diagnostic models to Implant Logic located in Cedarhurst, N.Y. A diagnostic wax-up is used to fabricate the radiographic guide (**FIGURE 12**). The radiographic guide is then fabricated using the barium crowns (which allow the visualization of the crowns in the CBCT scan), along with three radiographic markers that have been triangulated to the outside occlusal surface of the guide (**FIGURE 13**). The guide is returned for imaging, a CBVT scan is taken with the patient wearing the guide. Using the Virtual Implant Placement program, the restorative dentist and surgeon plan the surgery. The radiographic guide, along with the VIP treatment plan, is returned to Implant Logic. Implant Logic then uses the treatment plan with their computer-aided five-axis milling machine

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FIGURE 16. Implant delivery through surgical guide. *(Image provided by Implant Logic.)*

FIGURE 17. Three-dimensional rendering of the mandible. *(Image created in Simplant, C-Dental X-Ray, Inc.)*

FIGURE 18. Simplant radiographic guide with barium sulfate. *(Image provided by Materialise – Simplant.)*

and fabricates Compu-Guide (**FIGURE 14**). Two types of guides are available, the Pilot Compu-Guide and the Complete Compu-Guide (**FIGURE 15**). Pilot Compu-Guides start at $195 with each additional implant site costing $50. The Complete Compu-Guide starts at $195 with each addition implants site costing $75. The Complete Compu-Guide includes both the Pilot Compu-Guide and additional guides needed for remainder of drilling. An important feature of the Complete Compu-Guide is the ability to deliver implants through the guide (**FIGURE 16**). The cost of the VIP software is $3,600. From the patient's initial appointment with the doctor, it takes approximately 15 working days to receive their Compu-Guide. For nonaesthetic implant sites, Implant Logic makes a template for the radiographic guide that can be fabricated in the doctor's office. This option can reduce time between the first office visit and receipt of the surgical guide. Additional information about Implant Logic's Compu-Guide can be found at www.implantlogic.com.

Treatment Planning With STL Files

Simplant, Nobel Biocare, and iDent utilize stereolithography files (STL) to manufacture their guides.

An STL is a file format native to the stereolithography CAD software created by 3D-Systems. This file format is supported by many other software packages; it is widely used for rapid prototyping and computer-aided manufacturing. STL machines are basically 3-D printers that can build any volume shape as a series of slices.[5]

Materialise's 3-D Treatment Program

Materialise, a 3-D software and rapid-prototyping company in Belgium, manufactures three different types of surgical guides; bone, mucosa, and tooth- supported. SurgiGuides are manufactured utilizing their 3-D treatment program, Simplant. Simplant exports its proprietary file format into a universal STL file. This file is used to manufacture the SurgiGuide. Bone-supported SurgiGuide's are entirely manufactured from the CBCT data (**FIGURE 17**). The mucosa-supported guide for fully edentulous patients (enabling a flapless surgery) requires a duplicate of a well-fitting denture or a set of diagnostic models with wax-up. In this case, both the base plate and crowns of radiographic guide must consist of 15 percent barium ($BaSo_4$) and 85 percent acrylic (**FIGURE 18**). For tooth-supported guides, the radiographic guide should be fabricated of clear acrylic; the crowns should be made of the same barium-acrylic mixture. The mixture of barium and clear acrylic permits the visualization of the crowns in the treatment planning program. Where prosthetics are of no concern, the scan can be taken with no radiographic guide at all. The manufacturing of the SurgiGuide necessitates the treatment plan and patient models be sent to Belgium. It takes approximately 10 working days for the clinician to receive the surgical guide.

Currently, guides start at $400 regardless of quantity of sites. This includes a series of three guides. Each additional guide needed for additional drill sizes are $50. SAFE system guides, which utilize a master sleeve and allow for depth control, start at $400 with each additional osteotomy site at $25. Implants can be delivered through the SAFE system guides. Simplant treatment planning software (Simplant Planner) is priced at $3,775-$4,490. A free Simplant viewer is also available for the viewing of treatment plans created in the full version of Simplant Planner. Additional information about Materialise's SurgiGuides can be found at www.materialisedental.com.

Nobel Biocare's 3-D Treatment Program

Nobel Biocare, an implant manufacturer in Sweden, has recently developed 3-D planning software of its own, Procera. The Procera platform utilizes the dual-scan technique. This protocol calls for a radiographic guide fabricated from radio-transparent material (such as clear acrylic) and is marked with 8-10 gutta-percha markers on the lingual or buccal flange of the guide. A patient's well-fitting existing prosthesis can be marked with gutta-percha and also used (**FIGURE 19**). The patient is scanned wearing the guide and the guide itself is scanned alone. Again, the guide must represent the patient's final prosthetic appliance thus enabling maximum prosthetic planning in the Procera software. The software uses the gutta-perch markers as reference points to merge the two scans. The guide can now be distinguished in the software (**FIGURE 20**). The treatment plan is rendered in the Procera software.

Once the treatment plan is applied to the virtual guide, an STL file is rendered. This file essentially becomes a digital duplicate of the radiographic

FIGURE 19. Well-fitting hard lined maxillary denture with eight gutta-percha markers. *(C-Dental X-Ray, Inc.)*

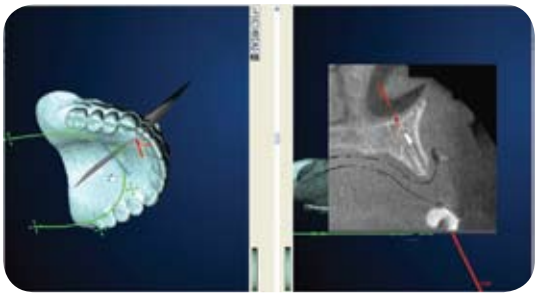

FIGURE 20. Three-dimensional view of surgical guide with implant trajectory and cross sections. *(Images created in Nobel Biocare's Procera Software, C-Dental X-Ray, Inc.)*

FIGURE 21. Model and model with radiographic guide. *(Images provide by Graham Simpson, DDS.)*

FIGURE 22. Three-dimensional rendering of radiographic guide. *(Image created in iDent's Scan2Guide software, provided by McCormack Dental Imaging.)*

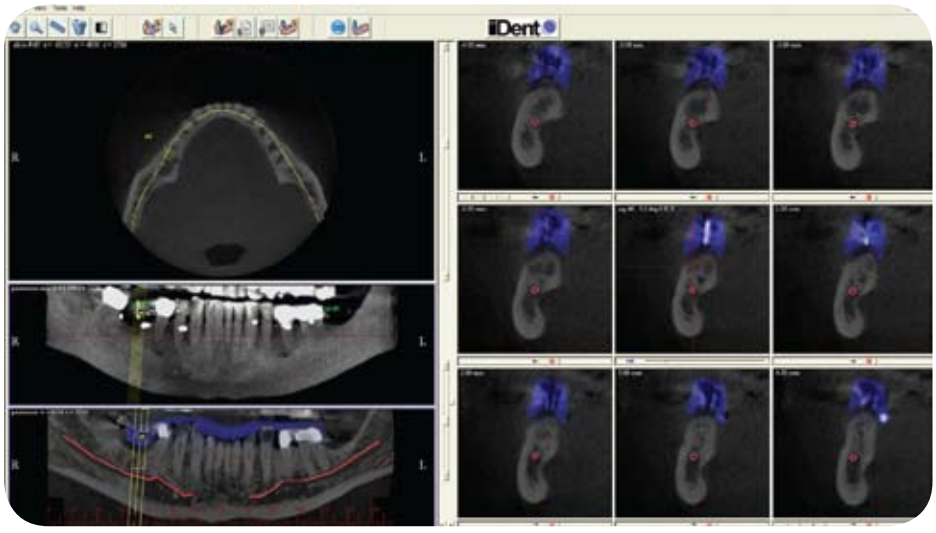

FIGURE 23. Axial, panoramic, and cross-sectional views of patient's CBCT scan with radiographic guide shown in blue. *(Images created in iDent's Scan2Guide software, provided by McCormack Dental Imaging.)*

guide with the necessary tunnels for the surgery. The surgical guide will fit as well as the radiographic guide. Nobel Guides use a master sleeve system so only one guide is necessary for the surgery. Total time up to receipt of the surgical guide is 10 working days. Nobel Guides range in price from $350 to $600. The Procera software starts at $3,500. Additional information about Nobel Biocare's Nobel Guides can be found at www.nobelbiocare.com.

iDent's Treatment Planning Program

iDent, located in Tel Aviv, Israel, is the maker of the Scan2Guide software. Unlike other manufacturers of surgical guides, they have licensed their technology for manufacturing guides in the United States. This system also utilizes the dual scan technique merging scan data together much like the Procera system. The radiographic guide required is also similar but requires only six gutta-percha markers. Existing well-fitting prostheses can be used. Accurate representation of the crowns to be restored is critical to utilize the software as a prosthetic planning tool. The radiographic guide can be visualized in all planes of the CT image. From the treatment plan that is rendered, in the software, a STL file of the iGuide is created. The STL file is the 3-D model of the iGuide that will be produced. It is essentially a digital duplicate of the radiographic guide with changes made by the software for the treatment plan the user has rendered. Using rapid prototype printing the guide is fabricated. This guide will be accurate to .2 tenths of a mm and can be used with any implant platform. Generally, the time between the scan of the patient and receipt of the iGuide is four working days. iGuides start at $200 for a guide with a single site, and $20 for additional sites. The cost of the Scan2Guide software is $1,000. For more information on the Scan2Guide system, visit www.ident-surgical.com.

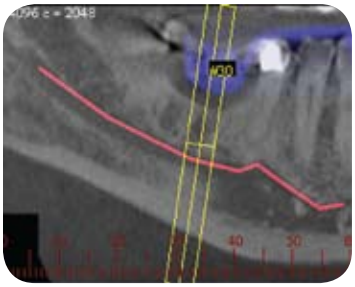

FIGURE 24. Adjustment of implant trajectory in panoramic. *(Images created in iDent's Scan2Guide software, provided by McCormack Dental Imaging.)*

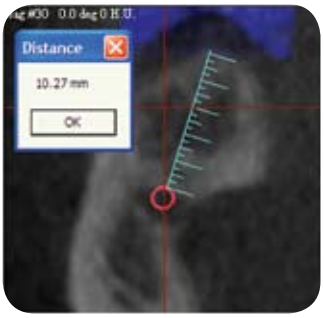

FIGURE 25. Measurement in the center cross section of the desired implant site from the inferior alveolar nerve canal to the alveolar crest. *(Images created in iDent's Scan2Guide software, provided by McCormack Dental Imaging.)*

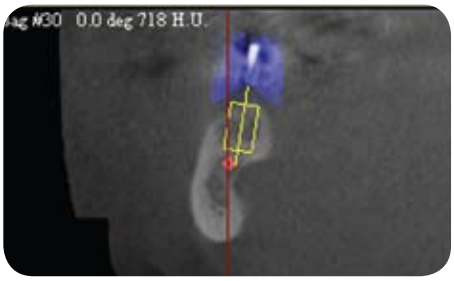

FIGURE 26. Initial placement of implant. *(Images created in iDent's Scan2Guide software, provided by McCormack Dental Imaging.)*

Illustration Case Using iDent's Scan2Guide

The patient, a 66-year-old male, had been seen by a prosthodontist for the possible placement of an implant for No. 30. The patient was tired of wearing a removable partial and inquired about implant placement. At the consultation, the patient was advised of his choices: a new partial, a three-unit bridge, or an implant. The patient was inclined toward the implant. When the patient was informed of the risks of the procedure, he voiced immediate concern that the nerve canal could be damaged by the placement of the implant and the resulting complications. The decision was made to manufacture a radiographic guide and have the patient imaged using CBVT.

Construction of Radiographic Guide and Image Analysis

The concerns were the proximity of the implant to the inferior alveolar nerve canal, buccal and lingual plates, and the proper emergence profile. Plaster models were fabricated, and, from that, a radiographic guide was fabricated according to the protocols of the 3-D treatment software used for this case (**FIGURE 21**). The patient was scanned wearing the radiographic guide. According to the radiographic protocol, the guide was scanned alone and now represents the digital duplicate of the radiographic guide (**FIGURE 22**). The scan of the patient wearing the radiographic guide and the separate scan of the guide are then fused, allowing the visualization of the guide in the CBVT scan.

In this case (**FIGURE 23**), the radiographic guide is visualized in blue; the image in the upper left hand corner is the axial view. This view is one of 118 axial slices, each 1 mm thick and spaced .4 mm apart. Scrolling through these slices allows the clinician to visualize the width of the mandible from its inferior border to the occlusal surface. The panoramic directly below the axial image is a maximum intensity projection. The MIP image is a full-surface rendering of anatomical structures. The panoramic image in the lower left hand corner is 1 mm thick. The yellow line in the axial view directly correlates to the delineation of the inferior alveolar nerve canal in the 1 mm panoramic. The yellow line is pushed buccal-lingually until the nerve canal becomes clearly visualized in the panoramic view. A marking tool is used to mark the superior aspect of the canal and the canal's anterior extension. The software automatically designates the location of the nerve in the nine cross sections.

The three yellow lines in the panoramic view represent the anterior-posterior plane of the cross sections and can be adjusted to help determine the proper emergence profile. In this case, the prosthodontist chose a profile parallel to the roots of the adjacent teeth as shown in (**FIGURE 24**). Measurements were taken from the superior aspect of the inferior alveolar nerve canal to the alveolar crest to determine the height of bone and the length of implant that can be placed. The software provides an actual 1:1 distance of 10.27 mm (**FIGURE 25**). Based on the measurements taken, a 4 mm x 4 mm x 8.5 mm implant was chosen (**FIGURE 26**).

To ensure the optimum position additional measurements were taken showing 1.47 mm from the lingual apex of the implant to the lingual plate and a distance of 1.48 mm from the apex of the implant to the superior aspect of the nerve canal (**FIGURE 27**). The decision was then made to use a 4 x 4 x 7 mm implant. This produced acceptable distances of 2.64 mm from the apex of the implant to the superior aspect of the canal as well as the distance of the implant to the lingual plate (**FIGURE 28**).

The implant placement is then analyzed in another dimension by scrolling through the axial slices helping to ensure there is not communication between the implant and the periodontal ligament of the adjacent teeth (**FIGURE 29**). An additional feature of the software provides the clinician with bone density measurements in Hounsfield units from the apex to the coronal aspect of the implant. The bone density of the planned implant location helps the clinician in determining Type 1, 2, 3, or 4 bone qualities (**FIGURE 30**).

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FIGURE 27. Measurements taken from the lingual apex of the implant to the lingual plate and from the apex of the implant to superior aspect of the alveolar nerve canal when a 4 mm x 4 mm x 8.5 mm implant is placed. *(Images created in iDent's Scan2Guide software, provided by McCormack Dental Imaging.)*

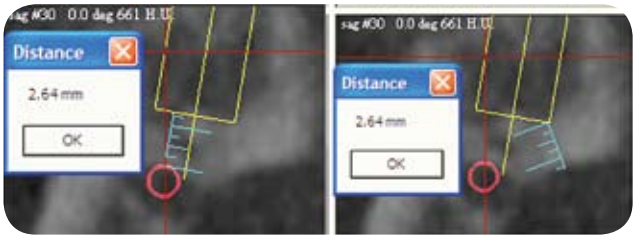

FIGURE 28. Measurements taken from the lingual apex of the implant to the lingual plate and from the apex of the implant to inferior alveolar nerve canal when a 4 mm x 4 mm x 7 mm implant is placed. *(Images created in iDent's Scan2-Guide software, provided by McCormack Dental Imaging.)*

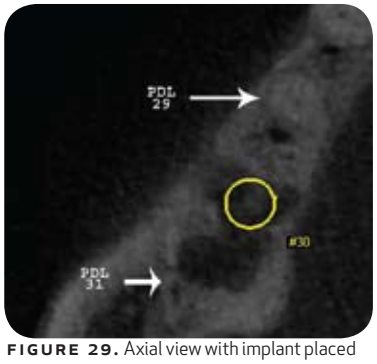

FIGURE 29. Axial view with implant placed showing proximity of adjacent teeth's PDL. *(Images created in iDent's Scan2Guide software, provided by McCormack Dental Imaging.)*

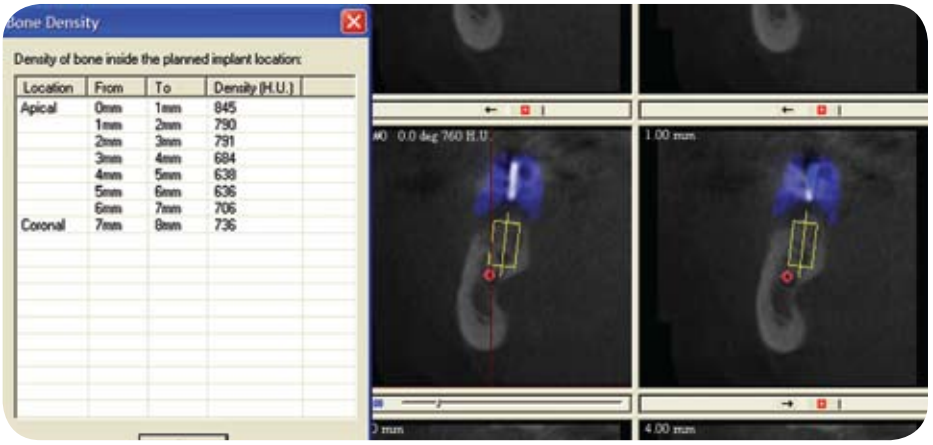

FIGURE 30. Density of bone surrounding planned implant location, provided in Hounsfield units. *(Images created in iDent's Scan2Guide software, provided by McCormack Dental Imaging.)*

FIGURE 31. Surgical guides with graduated sleeve size to accommodate surgical drills. *(Image provide by Graham Simpson, DDS.)*

FIGURE 32. Handles tools, which are inserted in master sleeve of the surgical guide according to drill size. *(Image provided by Graham Simpson, DDS.)*

Application of STL Model and Use of the Surgical Guide

The virtual guide is rendered within the software. Through rapid-prototype printing, a digital duplicate is created from the STL file. The STL file is sent to the rapid prototype printer. The printer lays out 16 micron layers of light-cured acrylic in manufacturing the guide. Titanium sleeves are then placed into the tunnel of the guide. Each guide has a sleeve with one-tenth of a millimeter tolerance for each drill used in the surgery (**FIGURE 31**). The cost of multiple guides can be reduced by utilizing a master sleeve. The master sleeve facilitates the placement of handled sleeves, which are custom made to a tolerance of one-tenth of a mm to each individual drill (**FIGURE 32**). The surgical guide ensures a proper placement of the implant per the virtual treatment plan (**FIGURE 33**).

A typical clinical case planned from with CBVT and 3D treatment planning would look like **FIGURE 34**.

Discussion

CBCT and 3-D treatment planning are emerging technologies for dentistry that offer alternative imaging options between 2-D imaging and model-based planning. The case examples illustrate how computer-assisted imaging, with multiplane views, a digitally manufactured surgical guide, with an accuracy of .3 mm, provide the clinician with the necessary information as to the proper prosthetic placement of implants. This .3 mm accuracy is achieved by using a CBCT with a voxel size of .2 mm and a drill sleeve with .1 mm tolerance to the drill. CBCT and 3-D imaging also improve the communication between the surgeon, restorative dentist and patient. Through the 3-D treatment planning the clinician is better able to understand the limitations that may be encountered in surgery before a flap is laid. These imaging and manufacturing capabilities do not exist with 2-D imaging and model-based treatment planning (**TABLE 1**).

FIGURE 33. Surgical guide in place at time of surgery. *(Image provide by Graham Simpson, DDS.)*

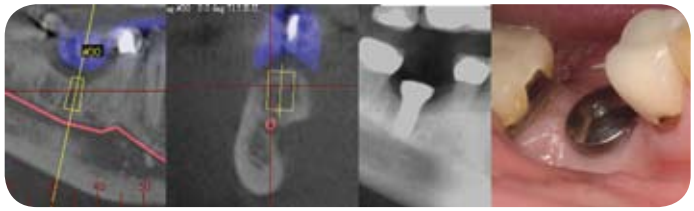

FIGURE 34. A typical clinical case planned from with CBVT and 3-D treatment planning. *(Images provide by Graham Simpson, DDS, and McCormack Dental Imaging.)*

TABLE 1

Limitations of Model of Based Treatment Planning as Compared to 3-D Planning

	Model-based treatment planning with CBCT	3-D treatment planning with CBCT
Ability to visualize the anatomy in the 3 dimensions and determine real relationships between structures	X	X
Ability to accurately apply information and measurement taken from CBCT data to the surgical procedure		X
Ability to accurately choose the best size and placement of dental implants		X
Once implant is virtually placed, 1:1 measurements can be obtained		X
Ensured placement in a compromised ridge situation, such as sinus lifts and ridge augmentation		X
Ability to establish final profile emergence of implant	X	X
Ability to determine proximity of implant to adjacent roots and PDL using panoramic, cross-sectional and axial views		X
Ability to manipulate CBCT data when treatment planning		X
Ability to assess bone density surrounding implant		X
Ability to manufacture surgical guide	X	X
Ability to manufacture guide with accuracy to .3 mm		X
Improved communication between surgeon and restorative dentist through online treatment planning		X

Conclusion

CBCT and 3-D treatment planning are emerging technologies that provide the clinician with the necessary information for routine and complex cases involving the placement of implants in the mandible or maxilla. ■■■■

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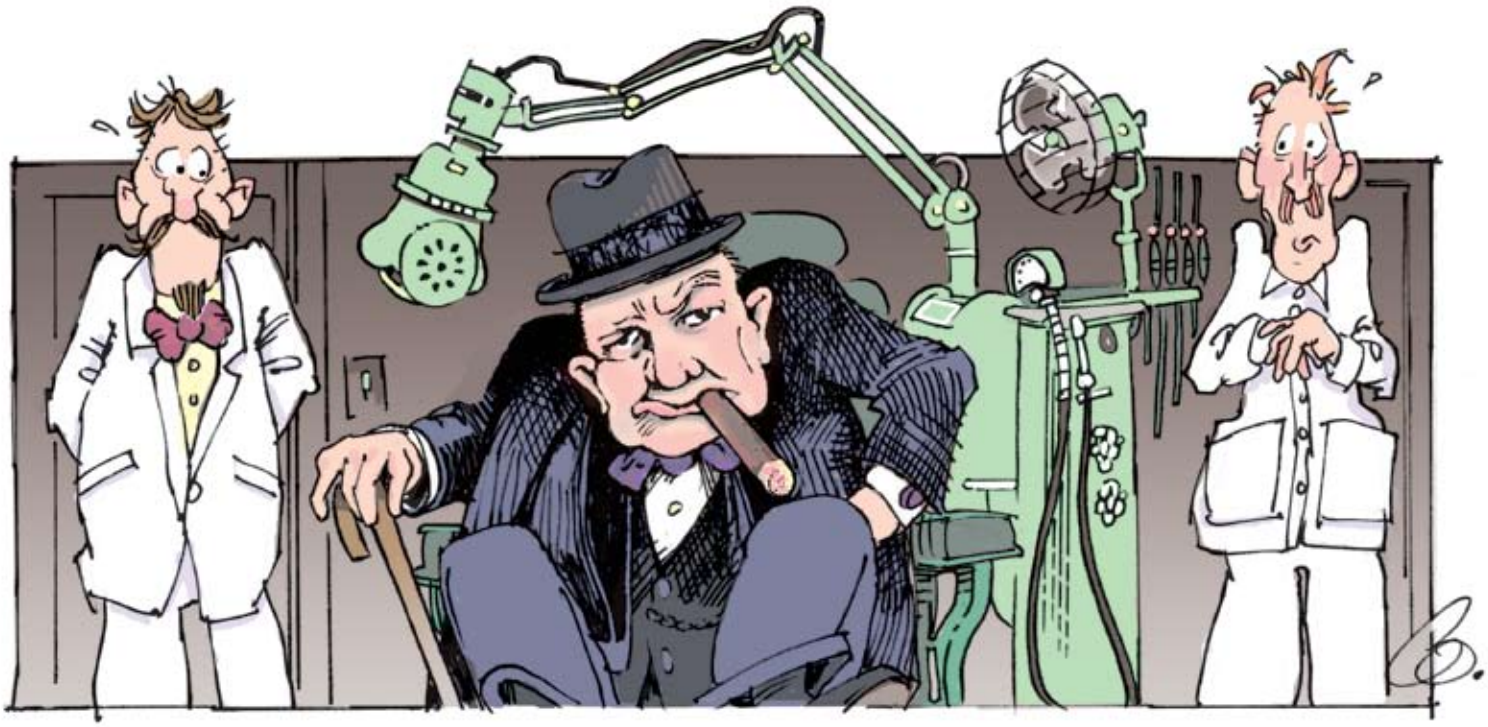
Churchill and Other A-lighters



For reasons that are not quite clear, his speech impediment became a famous hallmark, one that needed to be preserved at all costs.

Robert E. Horseman, DDS

ILLUSTRATION BY CHARLIE O. HAYWARD

How many of us have had a famous person or celebrity as a patient? Very few, I suspect. Considering the number of people who consider themselves renown, even if only in their own minds, it's remarkable how lucky we are. Admittedly, a certain ego-building satisfaction comes with having high-profile patients. This can be occasionally diminished by their highly developed sense of entitlement. I had a city councilman once, but he only lasted one term, so the mantle of celebrity dentist never draped for long over my sloping shoulders.

Some dentists thrive on pressure. I don't know any. Dentists aren't really all that fond of treating one another, as a matter of fact. To be known as a "dentist's dentist" might privately bolster your self-esteem, but at what price? The stress is maximized, the fee minimized. And what if your patient happens to be a world-famous leader? Historians will record every aspect of his or her life to the end of time and don't think the icon's teeth won't come under close scrutiny, especially if they played any significant role in it.

Nowhere is this more apparent than the case of Sir Winston Churchill, prime minister of England from 1940 to 1945 and again from 1950 to 1954. Everyone who has ever heard the recorded voice of Churchill reassuring the British people during the Battle of Britain "... we shall fight on the beaches, we shall fight on the landing grounds ..." would recognize the voice even if it were placing an order for fish and chips.

From early childhood, Churchill suffered from a pronounced lisp. He was never able to produce a proper "s" although he eventually managed to make the "sh" sound after practicing something

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DR. BOB, CONTINUED FROM 314

like "sister Susie sells seashells by the seashore." For reasons that are not quite clear, his speech impediment became a famous hallmark, one that needed to be preserved at all costs. When he made that noted statement in reference to British fighter pilots during the Battle of Britain: "Never in the field of human conflict was so much owed by so many to so few," he might just as well been speaking of the British dentists who were able to save his distinctive speech patterns.

Somewhere early in his career that saw him entering Parliament age the age of 26, he lost his upper laterals and centrals, and the pair of upper left bicuspids. Parliamentary debates can become quite agitated at times, but history seems to have overlooked the actual etiology of these particular losses. In any event, they were replaced initially by a vulcanite denture with the predictable results. He wore it in his pocket more often than his mouth, eventually sitting on it and breaking it.

Enter Wilfred Fish, a dentist, and Derek Cudlipp, a dental technician, a pair of professionals with the patience of Job. They were destined to see Churchill through war and peace with such dedication that it should have qualified them for sainthood, if not knighthood.

Technical note: Fish and Cudlipp made a cast gold partial with porcelain teeth facings and clasps on Nos. 14 and 6. They discovered immediately that the horseshoe-shaped casting must not touch the palate. There had to be a minute amount of spacing to compensate for the lisp, or the entire Churchillian speech pattern was lost. Don't ask why. These intraoral tinkerings involved many appointments during which Churchill smoked two cigars and used brandy as a mouthwash. It is not recorded what Fish and Cudlipp used; Xanax hadn't been invented yet. When the prime minister's patience became exhausted with the adjustments, he would place his thumb in his mouth against the metal palate and flick it across the room. I've seen people do this in Italian movies, but never knew what it meant.

Winnie broke everything. Not all at once, but a facing here, a clasp there until it became obvious to the dental team they would have to make at least four partials to keep the speeches flowing and the war on an even keel. This was a grave responsibility for a dentist and his lab man, but that's part of the deal when you become a celebrity dentist. Hitler's dentist probably had no easier time, but it was der fuhrer's mustache rather than a speech impediment that had to be preserved. Not the dentist's fault it was flammable.

If you would like to be a celebrity dentist or feel you may be in danger of becoming one, there are several additions to the patient introduction sheet to consider:

- Are you now, or have you ever been, a celebrity?
- If you answered **YES**, do you believe your mere presence in this office is adequate compensation for our services?
- Do you believe opinions other than your own have any validity?
- Will you be accompanied by more than two large, heavyset individuals?

Please leave their rap sheets and this form at the front desk. We will call you … probably. ■■■■