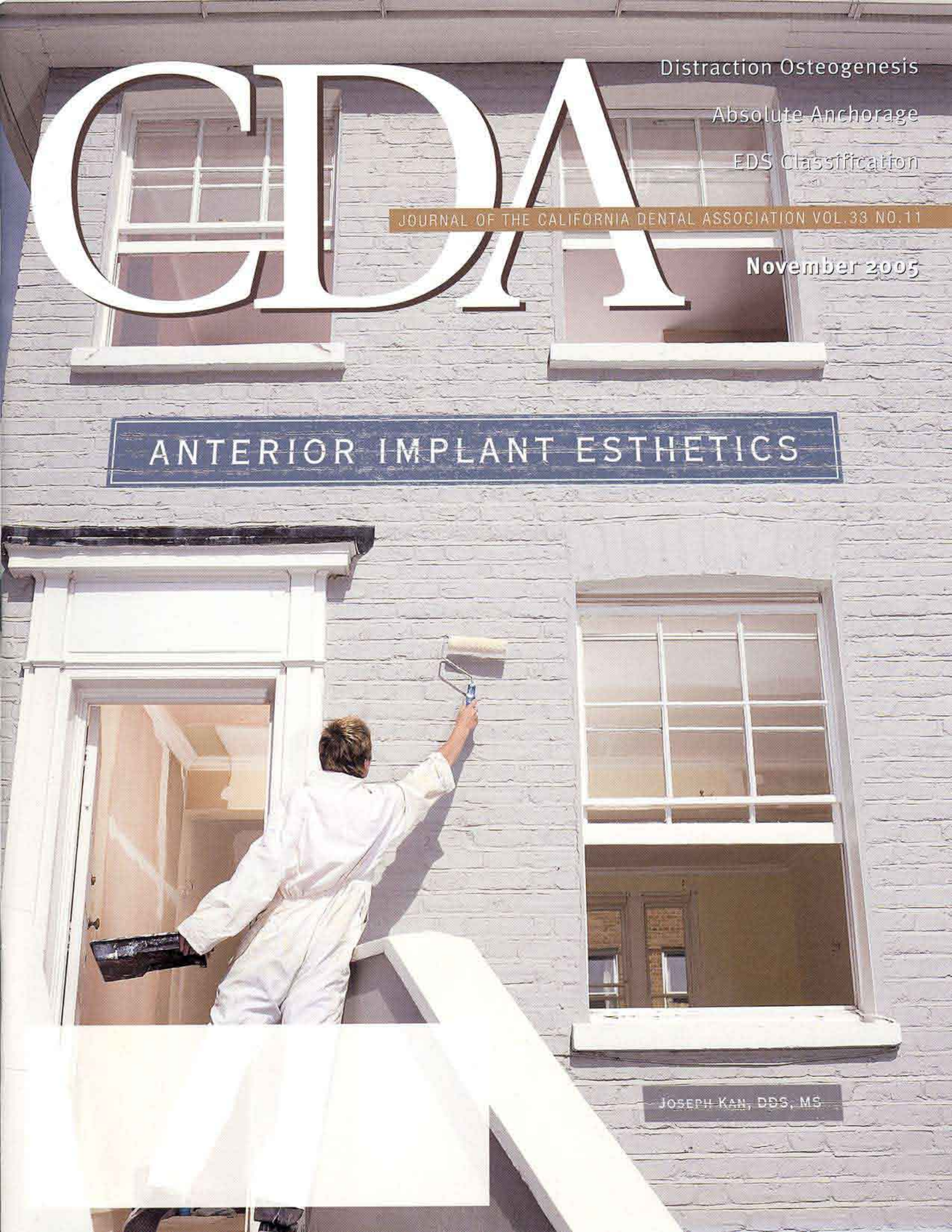
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ANTERIOR IMPLANT ESTHETICS
Joseph Kan, DDS, MS

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Partners in Care

In the past 10 years, we have witnessed the introduction of a new category of dental hygienists in California, the registered dental hygienist in alternative practice, or RDHAP. For some, this may be a new term and there may be confusion as to who these new practitioners are. Others may be more familiar with the history of the RDHAPs or have been involved in the legislation surrounding their inception. Regardless of readers' particular level of understanding or interest surrounding RDHAPs, the fact is, they are here and they are affecting the oral health care picture in California. Their numbers will continue to increase as will the role they play in providing dental care. It would be in the best interest of California dentists to take note and to play an active role in the evolution of the RDHAP movement.

It is important to understand what qualifies an individual to hold an RDHAP license and what they can and cannot do by law. An RDHAP must have a valid registered dental hygiene license and have completed 150 hours of coursework in an approved RDHAP program. There are currently two active RDHAP training programs, one at West L.A. College and the other at UOP. Some RDHAPs may be licensed prior to 1997 under the Health Manpower Pilot Project. An RDHAP may perform all the duties a RDH may perform, with some exceptions. They may provide some duties that a RDH can only provide under general supervision but cannot provide those RDH services that require direct supervision. Thus, they cannot prepare bleaching trays or administer local anesthesia or nitrous oxide sedation. They can provide allowed services in residences of the homebound, schools, residential facilities and other institutions, and dental health professional shortage areas as defined by the Office of Statewide Health Planning and Development.

Further regulations require RDHAPs to have an existing relationship with at least one dentist for referrals and they can only provide care to a patient who presents a prescription from a dentist or physician. This information is available in greater detail through the California Dental Association and is summarized in their RDHAP fact sheet.

In my experience, the majority of dentists have reacted negatively to the creation of the RDHAP position. Perhaps this is residual from a longer-standing, largely adversarial relationship between the dental profession and the dental hygiene profession. While individual dentists and hygienists often forge very positive working relationships, the relationship between the organizations representing the two groups seems to range from one of tenuous co-existence, to one of outright mistrust and poor cooperation.

The arrival of RDHAPs represents yet another change to the oral health care structure. We have come quite a long way from the days when the general dentist had near totalitarian control over all aspects of dental care. Dentists not only performed all procedures now shared by specialists, they also performed their own laboratory work and their own hygiene services as well. This did not

It would be in the best interest of California dentists to take note and to play an active role in the evolution of the RDHAP movement.

One must remember that in all change there is opportunity.
The greatest threat from change comes when we try too hard to resist it.

necessarily represent a state of better patient care. In fact, the opposite can be said; that the addition of dental specialists, laboratory technicians, and dental hygienists have drastically improved the level of care delivered by sharing duties and responsibilities, and allowing general dentists to pursue and master procedures that would have been previously impossible. Nevertheless, most people are uncomfortable with change. It represents a threat to a comfortable and stable state. One must remember that in all change there is opportunity. The greatest threat from change comes when we try too hard to resist it. When we work with change synergistically, then we cross the threshold from being victims of outside circumstances to shapers of the future.

Incorporating RDHAPs effectively into the healthcare system will not come without some effort and growing pains for the profession. Concerns expressed by dentists thus far have validity and must be addressed. Some dentists are critical of the efforts by RDHAPs to eliminate the stipulation that a prescription be required prior to providing care. A proactive response would be for dentists to actively begin forging relationships with RDHAP practitioners in their area and utilize their services as currently outlined by existing law. If it can be demonstrated that the current prescription requirement not only provides for patient protection but is being effectively utilized, then arguments against eliminating this requirement can be made to legislators.

Another fear is that RDHAPs will try to expand their existing allowed duties, providing services which dentists feel are best left in their own hands. Of this we must keep in mind a simple truism. That humans are naturally prone to improve their own lot and expand on their skills and knowledge. RDHAP training programs will naturally evolve over time to include such additional skills and knowledge. Licensees will, in turn, seek to expand their duties accordingly. It was only recently that dentists found themselves in a similar position when the profession attempted, unsuccessfully, to expand the duties of California oral and maxillofacial surgeons. Scope of practice issues do have a profound impact on the delivery of care and protection of the public, however categorically opposing expansion of duties that happen to encroach on our own is likely to be viewed primarily as self-serving.

There are also concerns about risk and liability incurred by individual dentists who choose to establish a working relationship with an RDHAP. On its fact sheet, CDA offers several recommendations regarding dentist responsibilities. These include a properly drafted independent contractor arrangement between the dentist and RDHAP, proper follow-up treatment performed by the dentist including regular examinations and radiographs, and verification of the RDHAP's liability insurance.

With an understanding of this new member of the dental team and an acquired level of comfort with the working relationship, it takes only a little forward thinking to help patients realize a benefit from their services. When I look at my patients, I see not only a diverse population, but one in transition. Many will live well into their 90s. While some of these individuals will enjoy relatively good health, others will battle chronic and debilitating diseases. They fall somewhere between a younger generation enjoying fewer carious and restored teeth thanks to better preventive services, and an older generation which experienced significant tooth loss and removable prosthetic needs. As such, they will have an extensive need for restorative and preventive dentistry, including hygiene services. Many will eventually be rendered unable to travel to my office for this care. For these patients, I see hope for better oral health with the help of RDHAPs. These oral health care providers can serve as more than just another licensee category in our state and they deserve to be treated not as adversaries, but as partners in care. In this spirit, our patients will benefit; and isn't that the real bottom line result we should all be working toward?

Correction: *In my commentary, "Not For Sale" (Pages 589-90, August* CDA Journal) *I referred to a deal between the American Academy of Pediatric Dentistry and Coca-Cola in which the latter provided money to the former to fund research grants. I further mentioned that the AAPD subsequently withdrew from this relationship under member criticism. This is, in fact, not the case. A source informed me that this money was accepted by AAPD and research grants were subsequently awarded. I apologize for the error.* CDA

Illustration: Matt Mullin

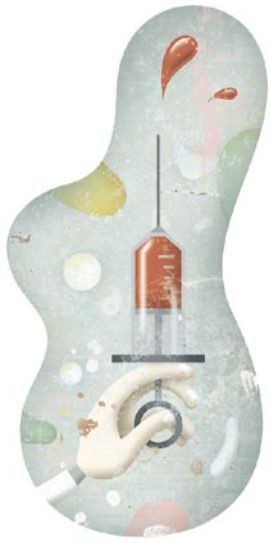
Efforts Under Way to Improve and Produce New Influenza Vaccine

The U.S. Health and Human Services recently awarded a $97 million contract that will promote the development and production of cell-based vaccines over the egg-based version. The five-year contract to Sanofi Pasteur also includes plans to create a cell-cultured vaccine manufacturing facility in the United States.

"This action begins the process of speeding up influenza vaccine production, improving surge capacity and scaling up U.S. manufacturing capability," said Mike Leavitt, HHS secretary.

"As a result, this should allow the United States to have influenza vaccines in a more timely, less laborious manner, and it provides another tool for responding to and controlling a global influenza pandemic," Leavitt said.

Cell-based flu vaccines use mammalian cells to grow the viruses used in the vac-



cine. Under the contract, Sanofi Pasteur is charged with developing and manufacturing clinical investigational lots of inactivated influenza vaccines using human cells.

The vaccines will be tested in human clinical trials in pediatric, adult, and elderly populations within the United States. In addition, Sanofi Pasteur will develop plans for a U.S. manufacturing facility, able to produce at least 300 million doses of a pandemic influenza vaccine using this technology.

The development and production of the cell-based vaccines is part of HHS' efforts in preparing for a pandemic. Other key areas range from surveillance, antiviral stockpiling, research, and public health preparedness.

In the 20th century, there were three influenza pandemics. The most recent occurred in 1968 with the Hong Kong flu outbreak, which resulted in close to 34,000 deaths in the United States alone. Eleven years earlier, the Asian flu claimed approximately 70,000 deaths. But the worst of all was the Spanish flu in 1918 that caused illnesses to an estimated 20 to 40 percent of the world's population and claimed more than 50 million deaths throughout the globe. Between September 1918 and April 1919, 675,000 Americans died from the Spanish flu.

The Sanofi Pasteur contract is one of several HHS has awarded during the last 12 months to boost epidemic influenza preparedness and the yearly influenza vaccine supply. Previous awards were made to secure year-round vaccine raw materials and supplies, add to the influenza vaccine capacity domestically, and develop pandemic-like vaccine candidates for clinical evaluation.

The cell-culture approach to producing the flu vaccine has many benefits. For example, manufacturers can skip the process to adapt the virus strains to grow in eggs. Additionally, cell culture-based flu vaccines will help meet surge capacity needs in case of a pandemic or shortage since cells may be frozen in advance and large volumes grown quickly. The U.S. licensure and manufacture of flu vaccines produced in cell cultures also provide security against risks associated with egg-based production, such as the potential contamination of egg supplies by various fowl-based diseases. Lastly, cell-based influenza vaccines provide an option for people allergic to eggs who presently cannot receive the current licensed vaccines.

Cell culture-based flu vaccines will help meet surge capacity needs in case of a pandemic or shortage since cells may be frozen in advance and large volumes grown quickly.

Currently, it takes almost nine months to produce licensed influenza vaccines using chicken eggs. But first, scientists must determine what they anticipate will be the predominant viral strains in the United States the following flu season. The strains then are adapted to grow in eggs. Manufacturers inject each adapted virus strain separately into millions of fertilized eggs, which then are incubated to produce the flu virus. Numerous batches of these eggs are harvested and mixed into one vaccine product that includes all three flu strains.

This new contract follows the August 2004 release of the draft National Pandemic Influenza Preparedness and Response Plan which outlines a coordinated national strategy to respond to and prepare for an influenza outbreak. The draft plan is online, http://www.hhs.gov/nvpo/pandemicplan.

The plan presents strategies to local, state and national policy makers as well as health departments for public health response and preparation in case of a widespread outbreak of influenza.

Herbal Remedies May Cause Harmful Interactions

With the rising use of herbal supplements and potentially dangerous interactions in taking them with other medications, it may be important for general dentists to become familiar with and knowledgeable of these alternative remedies.

Sales of herbal medicines increased from $2.5 billion in 1996 to an estimated $4.1 billion only five years later, according to the July 2005 issue of *AGD Impact*, the Academy of General Dentistry's news magazine. Many researchers speculate the spike in use can be attributed to a number of high-profile recalls in prescription medications.

Researchers have confirmed that some herbal remedies can be misidentified or improperly labeled as well as contain metals, pesticides, and substituted ingredients. Additionally, some of the ingredients in the herbals may interact with other medications — including dental prescriptions — or even other herbal medicines.

Marked bleeding during dental procedures including root planing, biopsies, tooth extractions and periodontal surgeries, as well as routine tasks such as fillings and cleanings, can be a common interaction between herbal remedies and drugs used in dentistry.

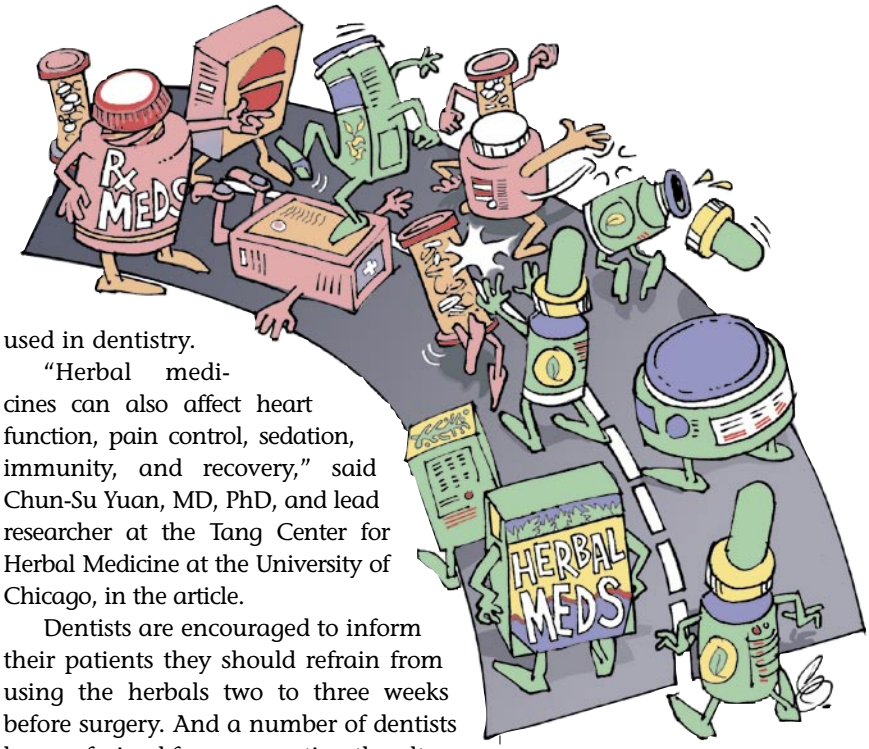


Illustration: Charlie O. Hayward

"Herbal medicines can also affect heart function, pain control, sedation, immunity, and recovery," said Chun-Su Yuan, MD, PhD, and lead researcher at the Tang Center for Herbal Medicine at the University of Chicago, in the article.

Dentists are encouraged to inform their patients they should refrain from using the herbals two to three weeks before surgery. And a number of dentists have refrained from suggesting the alternative remedies until more research has been completed and monitor their patients' use as a precautionary measure against negative interactions.

While the alternative remedies are natural, there is no requirement to put the herbal medicines through the same Federal Drug Administration testing as is mandatory with prescription medications. Additionally, herbal claims to prevent, treat, or cure particular ailments are not supported by clinical trials.

Oral Cancer Malpractice Claims on the Rise

Allegations of failure to diagnose oral cancer have the heftiest price tag of all claims of malpractice filed against dentists.

What's more, the allegations also are the toughest to defend, wrote Cliff Rapp in an issue of *Today's FDA*, the journal of the Florida Dental Association.

"Dentists should view all lesions, lumps and bumps as possible cancer," he advised, noting that sufficient documentation and early recognition are vital. Rapp also said dentists should "closely monitor patients who have suspicious lesions until a definitive diagnosis is made."

In studying the Physician Insurer's Association of America's closed claim data, the author found oral cancer claims to be on the upswing in the United States. Cases determined as "indefensible" fall into three categories: failure to biopsy; failure to re-examine a lesion and the patient's medical history; and office-system failure, permitting diagnostic reports to fall by the wayside.

Illustration: Matt Mullin

ADA Website Cautions of 'Meth Mouth' Problems

Efforts are under way to educate dental professionals and patients about the horrific effects of methamphetamine, a highly addictive and toxic drug that is associated with overall health problems and serious oral health issues known as "meth mouth."

The condition of methamphetamine users' teeth has been described as "blackened, stained, rotting, crumbling or falling apart," and frequently, the teeth must be extracted since they cannot be saved, according to an ADA media advisory.

In a national survey on drug use and health in 2003, an estimated 12.3 million Americans, or 5.2 percent of the population, as young as 12 years old experimented with meth at least once in their lives; a majority were between the ages of 18 and 34 and used in the past year.

"The American Dental Association wants more dentists and patients to understand the devastating effects the illegal drug methamphetamine has on oral health," said the ADA in a media statement. "In addition to numerous threats to overall health, methamphetamine users risk rampant tooth decay in a distinctive pattern on the smooth front surface of the teeth and the spaces between the front teeth."

The ADA website, ADA.org, provides an overview of the effects of methamphetamine use on oral health and a bibliography with drug abuse and research endnotes.

Information includes what dental professionals can do if they suspect a patient is using. Among the suggestions are:

- Complete a comprehensive oral exam, including a thorough medical and dental history,
- Educate the patient about the detrimental effects on oral health,
- Teach patients about the risks of using illegal drugs,
- Be cautious administering sedatives, nitrous oxide, local anesthetics, general anesthesia, or prescribing medications due to possible drug interactions,
- Refer patients to resources such as drug counseling or physician services,
- Utilize topical fluorides, and
- Encourage the patient to stop drinking sugary carbonated drinks and consume water instead.

"The oral effects of methamphetamine use can be devastating," according to a Dental Topics statement posting. "Reports have described rampant caries that resembles early childhood caries and is being referred to as 'meth mouth.' A distinctive caries pattern can often be seen on the buccal smooth surface of the teeth and the interproximal surfaces of the anterior teeth.

"The rampant caries associated with methamphetamine use is attributed to: the acidic nature of the drug, the drug's xerostomic effect, its propensity to cause cravings for high-calorie carbonated beverages, tooth grinding and clenching, and its long duration of action leading to extended periods of poor oral hygiene."

Additional efforts will contribute to an expanding information base for dental professional and patients on the condition of meth mouth. The *ADA Update* and *Community Brief* publications also will offer additional data, and the ADA Library will provide an information package. Courtesy of the Ohio Dental Association, ADA news coverage will include a first-person account.

"The topic has been the subject of media interest recently, and we anticipate that more and more dentists and their patients will want information about it," said James B. Bramson, DDS, ADA executive director.

Resistant Bacteria Afflicts U.S. Soldiers

According to an article in *The New York Times*, *Acinetobacter baumannii*, a drug-resistant type of bacteria, has caused a high rate of infection in injured soldiers returning from Iraq.

Acinetobacter baumannii lives in the water and soil in many areas of the world and invades the bloodstream, wounds, bones, lungs, and other body parts, according to the Aug. 4 news report. Antibiotics, including imipenem and amikacin can kill the bacteria; however, a particularly resistant strain can cause a prolonged infection.

A U.S. Army physician, as quoted by the *Times*, said approximately 240 cases have been treated over the past two years. And while there have been no direct casualties among American

Photo: Staff Sgt. Shane A. Cuomo, U.S. Air Force

veterans from Iraq with the bacteria, five very ill patients staying in the hospitals with those soldiers were infected and later died. It is unknown at this time whether the bacteria or original illnesses caused the patients' deaths, according to the *Times*.

'Growing' New Composite Materials Is a Possibility

The U.S. Department of Defense recently awarded a $550,000 grant to New York University College of Dentistry to purchase a nuclear magnetic resonance spectrometer, which allows scientists to study molecules in solid and liquid states.

John Evans, associate professor of basic care and craniofacial biology and chemistry said, in the spring 2005 issue of the university's *Global Health Nexus*, "Being able to manipulate matter on this tiniest of scales will lead to the introduction of novel materials and products affecting many areas of life. Dentistry is one case in point."

Evans also commented it might be possible to blend silicon and proteins in a culture dish to "grow" composites lighter and more resilient than materials now employed for dental restorations and implants.

Honors

Kevin D. Anderson, DDS, MAGD, of Jamul, continues his term as Academy of General Dentistry treasurer. He currently is a trustee for the California AGD, and a member of the Council on Annual Meetings and International Conferences, Budget and Finance Committee, as well as the 2004 Local Advisory Committee.

University of California San Francisco's **Peter Rechmann, DDS, PhD**, was elected to the 2005-2006 Board of Directors for the Academy of Laser Dentistry. Rechmann, professor and director of Clinical Research at UCSF's Division of Clinical General Dentistry, Department of Preventive and Restorative Dental Sciences, will serve as treasurer.

Joel M. White, DDS, MS, has been recognized with the Academy of Laser Dentistry Distinguished Service Award. White is a professor in the Division of Biomaterials and Bioengineering and John C. Greene Chair in Primary Care Dentistry, Department of Preventive and Restorative Dental Sciences at the University of California, San Francisco. The award is not given annually, but is reserved for individuals who demonstrate significant contributions to education, research, and the ALD.

Donation Benefits Students at Dugoni School of Dentistry

An Atlanta-based orthodontist is donating a total of $250,000 to the University of the Pacific Arthur A. Dugoni School of Dentistry to help with the rededication of the university. The donation by Robert N. Pickron, DDS, will be used to build a study hall for orthodontic residents.

"With this gift, Dr. Pickron makes a clear statement that excellence in dentistry begins with excellence in education," said Dugoni, dean of the University of the Pacific's dentistry school that bears his name.

The facility, the "Dr. Robert Pickron Family Residents Study," features private cubicles for residents to research and review cases, will be located away from the clinical area. Pickron chose the Dugoni school following a visit. "I felt like teachers had a humanistic approach to treatment, both for students and patients. Everyone is treated with respect and the care is exceptional. Teachers listen to students; in turn, students listen to and focus on patients needs. It is only through listening that we learn. And learning what they want and feel that enables us to make the right decisions for our patients."

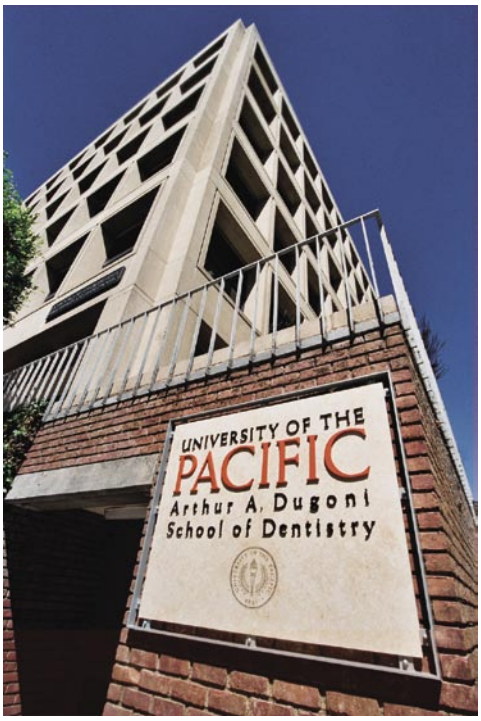


Photo: Courtesy University of the Pacific, Arthur A. Dugoni School of Dentistry

A second-generation dentist, Pickron is dedicated to discoveries and ongoing study. "Our constant commitment to learning is what distinguishes us as orthodontists and allows us to serve our patients with the best care possible."

Upcoming Meetings

2005

Nov. 4-6	Second International Conference on Evidence-Based Dentistry, Chicago, www.icebd.org.

2006

March 15-18	Academy of Laser Dentistry, Tucson, www.laserdentistry.org.
April 27-30	CDA Spring Session, Anaheim, (866) CDA-MEMBER (232-6362).
May 16-20	American Academy of Cosmetic Dentistry 22nd Annual Scientific Session, San Diego, (800) 543-9220.
Sept. 15-17	CDA Fall Session, San Francisco, (866) CDA-MEMBER (232-6362).
Oct. 16-19	ADA Annual Session, Las Vegas, (312) 440-2500.
Dec. 3-6	International Workshop of the International Cleft Lip and Palate Foundation, Chennai, India, (91) 44-24331696.

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

THE ESTHETIC CHALLENGE IN IMPLANT DENTISTRY

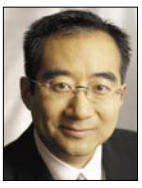
Joseph Y.K. Kan, DDS, MS

It is an honor to be the guest editor for the November 2005 issue of the *Journal of the California Dental Association*. For the past three decades, implant dentistry has undergone several phases of "makeover," from being an individual entity to being part of interdisciplinary treatment. Over the past decade, one of the biggest challenges in implant dentistry has been the development of peri-implant gingival esthetics, particularly in the anterior maxillary region. Peri-implant esthetics is defined as the presence of harmonious gingival architecture around the implant restoration and the surrounding dentition.

In the early 1990s, osseointegrated implants were commonly used in edentulous spaces where teeth had been removed. While sufficient for implant osseointegration, the residual hard and soft tissues were often inadequate for ideal peri-implant esthetics. The concept of tissue reconstruction has, therefore, been conceived and extensively experimented in order to overcome these shortcomings. Nevertheless, these grafting procedures are usually unpredictable, technique-sensitive and time consuming. Therefore, current concepts in tissue reconstruction involved utilizing orthodontic forces to attenuate rather than to recreate soft and hard tissues. Dr. Alan Herford's article "Distraction Osteogenesis: A Surgical Option For Restoring Missing Tissue In The Anterior Esthetic Zone" describes a technique to reconstruct alveolar defects by gradually expanding existing gingiva and the underlying bone. Dr. Kitichai Rungcharassaeng and Dr. Joseph Caruso's article comprehensively summarizes the various options of using implants as an orthodontic anchorage to attain a favorable esthetic and functional outcome.

Recently, in an attempt to avoid major grafting procedures, the concept of tissue preservation has evolved into implant site-development procedures where the failing tooth can be immediately replaced with provisional implant restorations. This technique requires the presence of the optimal architecture of the existing hard and soft tissues. The article by Dr. Sascha Jovanovic describes the required biologic elements to achieve successful anterior implant esthetics. Drs. Nicholas Caplanis and Jaime Lozada describe the method of assessing extraction defects and how they influence the treatment options. Additionally, the technique of immediate tooth replacement in conjunction with connective tissue grafts and its surgical rationale are described in detail.

The authors who have contributed to this issue, in their own right, are leaders in the field of implant dentistry. I hope that the articles in this issue of the *Journal* will provide useful insights for the readers to achieve anterior implant esthetics. CDA



Guest editor / Joseph Y.K. Kan, DDS, MS, is associate professor, Department of Restorative Dentistry, Loma Linda University School of Dentistry.

EXTRACTION DEFECT ASSESSMENT, CLASSIFICATION, AND MANAGEMENT

Nicholas Caplanis, DMD, MS; Jaime L. Lozada, DDS; and Joseph Y.K. Kan, DDS, MS

ABSTRACT

Tooth extraction is a traumatic procedure initiating a complex cascade of biochemical and histologic events that inevitably lead to a reduction of alveolar bone and soft tissue. These tissue alterations often lead to an esthetic compromise of the future implant restoration. The hard- and soft-tissue architecture surrounding the extraction defect largely dictates the course of dental implant treatment. The EDS or extraction-defect sounding classification is a novel system introduced to simplify the decision-making process when planning for dental implant therapy following tooth extraction. Dental implant treatment guidelines based on the EDS classification are discussed. A review of pretreatment evaluations necessary to prepare for esthetic implant procedures is also presented.

Tooth extraction is a traumatic procedure often resulting in immediate destruction and loss of alveolar bone and surrounding soft tissues. A complex cascade of biochemical and histologic events then ensues during the wound healing process which further leads to physiologic alterations to alveolar bone and soft-tissue architecture.[1-3]

The morphologic changes seen following tooth extraction can easily be reduced through current site preservation techniques. Atraumatic extraction techniques using microsurgical instrumentation including periotomes or similar devices, the use of hard-tissue graft materials derived from a variety of sources, graft-stabilizing membranes, as well as soft-tissue grafts can reduce the degree of damage and extent of resorption that physiologically occurs following tooth extraction.[4,5] The extraction socket with an undamaged alveolus and well-preserved soft tissues can be successfully treated with immediate implant placement.[6] When the hard- and soft-tissue architecture of the extraction defect is moderately to severely compromised, site preservation often in conjunction with site development procedures is commonly necessary.[7]

The clinical presentation of alveolar defects seen immediately following tooth removal varies from simple to complex. This evaluation can only be accurately made immediately following extraction, since damage often occurs during the process of tooth removal and the periodontal attachment commonly shrouds hard-tissue architecture. A classification of the extraction defect, as it presents immediately following tooth removal associated with dental implant treatment recommendations, would be beneficial for the clinician in establishing the most appropriate plan for treatment. The purpose of this paper is to present a novel extraction-defect classification system which categorizes extraction defects and provides clinical guidelines for dental implant treatment.



Authors / Nicholas Caplanis, DMD, MS, is assistant professor, Loma Linda University School of Dentistry. He is board certified and a diplomate of the American Board of Periodontology and maintains a full-time private practice limited to periodontics and dental implant surgery in Mission Viejo, Calif.

Jaime L. Lozada, DDS, is professor and director, Postgraduate Program in Implant Dentistry, Loma Linda University School of Dentistry.

Guest editor / Joseph Y.K. Kan, DDS, MS, is associate professor, Department of Restorative Dentistry, Loma Linda University School of Dentistry.

Pretreatment Evaluation

Medical History

A careful patient medical evaluation is paramount to the success of dental implant procedures. A thorough medical questionnaire and interview is necessary in order to assess and anticipate the patient's general healing potential and uncover possible systemic anomalies which could potentially compromise the procedural outcome. Factors that could compromise wound healing should be identified and documented. The most common include smoking, poorly controlled diabetes, impaired liver function, drug or alcohol abuse, long-term corticosteroid use, and extreme age.[8,9] Diminished regenerative outcomes may be expected with medically compromised patients and surgical procedures modified to accommodate for these deficiencies. These modifications may include planning a more conservative implant treatment sequence, using autogenous bone over other biomaterials when needed, placing interpositional connective tissue grafts in order to pre-empt recession, and increasing the healing times.

Dental History

A detailed dental history and thorough understanding of the pathology leading to the extraction is vital to the assessment and management of the extraction defect. Teeth with a history of endodontic pathology, apical surgery, trauma or advanced periodontal disease may impart a site with an inherent compromise in wound healing.[10] Teeth with a history of fistula, apical surgery, or deep periodontal pockets may present with missing bony walls following their removal, which may limit the regenerative outcomes. These factors, when well understood, will influence the type of materials selected and procedures performed. For example, when socket walls are missing, membranes may be necessary to guide tissues and stabilize graft material. When the surrounding tissues are anticipated to have a compromised healing response, osteogeneic grafts such as autogenous bone may be preferable over other graft materials.

Esthetic Evaluation

Prior to tooth removal, a dentogingival esthetic evaluation should be performed and details documented. This is vital when dealing with extractions in the esthetic zone or any extraction in the esthetically demanding or particular patient. Merely concentrating on the tooth to be extracted and the area of implant placement often leads to unfulfilled expectations for the patient and frustration for the practitioner. This evaluation should document the smile line to determine the extent of gingival display, the gingival margin positions of the adjacent teeth, including any asymmetries and lengths of papillae to help determine the inevitability or preclude the possibility of interproximal papilla loss ("black triangles"). In addition, malpositioned or rotated teeth should be noted, given their adverse effect on the adjacent alveolar architecture.

This esthetic evaluation will allow for accurate treatment planning and uncover the need for adjunctive therapy including presurgical orthodontics.[11] Orthodontic extrusion can very often reposition hard and soft tissues in order to help achieve an ideal final esthetic result. Orthodontics can also reposition teeth in order to create ideal intra-alveolar distances prior to dental implant placement. Currently accepted guidelines advocate a minimum of 2 mm of space between implant and adjacent tooth, and 3 mm between two adjacent implants in order to maintain interdental septa and interproximal soft tissue.[12,13]

A DETAILED DENTAL HISTORY AND THOROUGH UNDERSTANDING OF THE PATHOLOGY LEADING TO THE EXTRACTION IS VITAL TO THE ASSESSMENT AND MANAGEMENT OF THE EXTRACTION DEFECT.

Periodontal Evaluation

A comprehensive periodontal evaluation is fundamental to the success of extraction site management. This includes periapical radiographs of the area of concern, preferably a full-mouth series or panoramic radiograph when appropriate. The periodontal assessment should document the periodontal biotype, pocket depths, recessions, mobility, furcation involvements, as well as the presence of plaque, including the extent of inflammation, and bleeding on probing. This evaluation will allow for an accurate prediction of the behavior of the adjacent soft tissues following extraction. Alveolar destruction is often masked by soft-tissue inflammation and edema. Extraction of teeth adjacent to inflamed tissues, pathologic periodontal pockets or a reduced periodontium, will lead to marginal and interproximal tissue recession. Therefore, it is essential that periodontal disease be eradicated prior to implant placement and, if possible,

prior to tooth extraction in order to accurately predict final tissue positions in preparation for implant placement. This will also allow the opportunity to alter the surgical technique when necessary to minimize the unfavorable hard- and soft-tissue changes and communicate realistic expectations to the patient. A comprehensive periodontal evaluation embraced within the prosthetic treatment plan including recognition of individual tooth prognoses is vital for proper diagnosis and treatment planning. Given the success and predictability of dental implants, it is no longer prudent to maintain periodontally and endodontically compromised teeth within complex or extensive prosthetic treatment plans.

Periodontal Biotype

A subject of particular concern during the periodontal evaluation is the periodontal biotype.[14] A thorough understanding and documentation of the patient's periodontal biotype is critical in order to predict hard- and soft-tissue healing, as well as to allow modification of the surgical techniques to enhance esthetics. This understanding also will aid in patient communication and expectations. In a clinical study, two distinct tooth forms were observed and correlated with various soft-tissue clinical parameters leading to two discrete periodontal biotypes.[15]

The thick, flat periodontium is associated with short and wide tooth forms. This biotype is characterized by short and flat interproximal papilla, thick, fibrotic gingiva resistant to recession, wide zones of attached keratinized tissues and thick underlying alveolar bone which is resistant to resorption.[10] Wound healing is ideal in these situations with minimal amounts of bone resorption and soft-tissue recession following surgical manipulations, including extractions and implant surgery. Ideal implant soft-tissue esthetics can be predictably achieved in these patients without modifications to routine surgical protocols.

In contrast, the thin, scalloped periodontium is usually associated with long and narrow tooth forms. This biotype is characterized by long and pointy interproximal papilla, thin, friable gingiva, minimal amounts of attached keratinized tissues and thin underlying alveolar bone, which is frequently dehisced or fenestrated.[10] Following surgical procedures, marginal and interproximal tissue recession in conjunction with alveolar resorption can be expected in patients with this biotype.[14] Modifications of routine surgical protocols are necessary for these situations. A careful and atraumatic extraction technique using microsurgical instrumentation such as periotomes is vital to help preserve alveolar architecture. Site preservation techniques using bone graft materials can help reduce the extent of bone resorption.[4,5] Soft-tissue grafts, in conjunction with the extraction and implant placement, can help augment and offset the expected tissue recession. Prosthetic tissue manipulation using the interim prosthesis can help guide soft-tissue healing and establish an esthetic tissue profile.[16]

A CAREFUL AND ATRAUMATIC EXTRACTION TECHNIQUE USING MICROSURGICAL INSTRUMENTATION SUCH AS PERIOTOMES IS VITAL TO HELP PRESERVE ALVEOLAR ARCHITECTURE.

Periodontal biotype classification is very often difficult to distinctly classify. Patients frequently present with a moderate biotype. The two biotypes reported represented the extreme tails of the bell curve with the great majority (80 percent) of the assessments falling in the center of the curve.[15] This moderate biotype presentation can often deceive the practitioner in believing he or she is dealing with a thick, flat periodontium, thus expecting minimal tissue changes when in fact, the tissue healing response behaves as the thin, scalloped biotype. Therefore, many of the routine surgical protocol modifications previously mentioned used to deal with the thin, scalloped biotype should be considered in these moderate biotype situations as well.

Extraction Defect Assessment Techniques

Following tooth extraction, the dental implant treatment sequence is largely determined by the integrity of the existing hard and soft tissues.[11] Careful assessment of the extraction defect is therefore paramount to the success of esthetic implant procedures. Extraction defect assessments can be made with or without flap reflection. Given the improved soft-tissue response with flapless procedures, assessment of the extraction defect in this manner will be more challenging but preferable. A surgical template that displays the position of the restorative margin of the future restoration is essential for this classification and used to guide assessments.

Following tooth extraction, a visual inspection of the socket bony walls is initially made. Recognition of the number of remaining socket walls and their

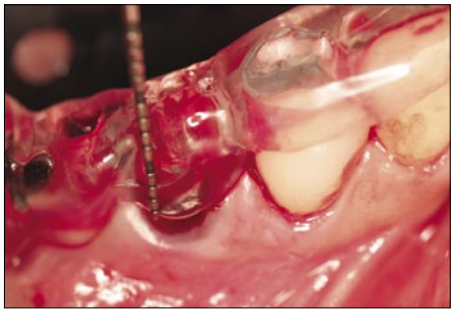


Figure 1. The EDS classification uses a surgical template to make measurements to critical landmarks immediately following tooth extraction.

condition is vital for this classification. Assessment of the gingival margin position and interproximal papillae and their relationship to the underlying alveolus is also vital. Classification of the periodontal biotype with associated risk assessment for potential recession is then determined. An additional important component of this evaluation also includes noting the degree of blood flow and potential for clot formation. A thorough debridement of the extraction socket and removal of all granulomatous tissue is performed and necessary to promote osseous repair.[17]

Extraction defect sounding is then performed. Using the tip of a conventional periodontal probe, the socket is thoroughly explored. Initially, the crest of the extraction defect is evaluated, noting the position of the crestal bone in relationship to the gingival margin, as well as to the future prosthetic gingival margin using the prefabricated surgical template (**Figure 1**). Any discrepancies between these two relationships should be noted. The risk of soft-tissue recession is proportional to the distance between existing bone and soft tissue; the more distant the position of the alveolus to the soft tissues, the greater the risk of gingival recession. Sounding of the bony crest includes the buccal and palatal plates as well as the interproximal bone peaks. Further examination of the buccal plate is then performed. While applying slight digital pressure on the outer buccal plate, the periodontal probe explores the inner aspect. This evaluation will uncover any fenestration or dehiscence-type defects. In addition, when sounding the inner aspect of the socket with a probe, any vibrations felt digitally will indicate a thin alveolar plate. A similar evaluation is also performed on the palatal plate. The thickness of the buccal plate is evaluated visually and digitally using a probe, as well as through manual palpation while sounding the inner aspect. A thin buccal alveolar plate often leads to partial or complete buccal plate loss following healing. When inadequate socket bleeding is present, perforations of the cribriform plate with a periodontal curette or rotary instrument is performed to facilitate wound healing.

Extraction Defect Sounding Classification

A novel extraction defect classification is outlined in **Table 1** and illustrated in **Diagram A**. The EDS, extraction defect sounding, classification describes the condition of the hard as well as soft tissues immediately following tooth removal, prior to healing and remodeling of the extraction socket and provides basic treatment guidelines to achieve predictable implant integration and esthetics. This classification only applies after the treatment decision has been made to remove a tooth and an objective evaluation of the extraction defect is made.

Extraction Defect — Type 1

The EDS-1 is characterized by a pristine, undamaged single-rooted socket, with a thick periodontal biotype in a systemically healthy patient. This defect allows for predictable immediate implant placement in a prosthetically ideal position.[6,18] An atraumatic surgical technique is vital in preparation for immediate implant placement and is a unique and more time-consuming process in contrast to conventional extraction techniques. This involves the use of microsurgical instrumentation such as periotomes and other similar devices and an acute regard to the preservation of tissues during tooth removal. The EDS-1 has four intact bony walls including a crestal buccal plate thickness of 1 mm or more. With the surgical template in position and using the cervical margin of the future restoration as a reference, the gingival margin should be at the level or above the reference point and the alveolar crest should be no more than 3 mm beyond.

Extraction Defect — Type 2

The EDS-2 is any socket with up to a mild degree of crestal bone damage or interproximal tissue loss of 2 mm, with a thin or thick biotype, a buccal plate thickness of less than 1 mm, or any combination thereof, in a systemically healthy patient. No more than one socket wall is compromised. The EDS-2 includes fenestrations that do not compromise the integrity of the crestal aspect of the buccal plate, such as apical endodontic damage. Another example of an EDS-2 would include an ideal socket as defined by the EDS-1 that has a thin instead of thick biotype. A further example would include a single-rooted bicuspid socket where the distance between the restorative margin of the surgical template and the alveolar crest is greater than 3 mm but no more than 5 mm. All multiple-rooted sockets with any of the above conditions are considered EDS-2.

Extraction Defect — Type 3

The EDS-3 is broadly defined. It is generally characterized by moderate com-

Table 1

The Extraction Defect Sounding Classification

Defect Type	General Assessment	#Socket Walls Affected	Biotype	Hard Tissue	Distance to Reference	Ideal Soft Tissue	Treatment Recommendations
EDS-1	Pristine	0	Thick	0 mm	0-3 mm	Predictable	Immediate implant (one-stage)
EDS-2	Pristine to slight damage	0-1	Thin or thick	0-2 mm	3-5 mm	Achievable but not predictable	Site preservation or immediate implant (one- or two-stage)
EDS-3	Moderate damage	1-2	Thin or thick	3-5 mm	6-8 mm	Slight compromise	Site preservation then implant placement (two-stage)
EDS-4	Severe damage	2-3	Thin or thick	≥6 mm	≥9 mm	Compromised	Site preservation then site development then implant placement (three-stage)

promise of the local tissues in a systemically healthy patient. This includes a vertical or transverse hard- and/or soft-tissue loss of 3 mm to 5 mm, one or two compromised socket walls, a thick or thin periodontal biotype, or any combination thereof. With the surgical template in position and using the cervical margin of the future restoration as a reference, the gingival margin is positioned 3 mm to 5 mm away from this cervical margin reference point and the crest 6 mm to 8 mm away. This type of defect does not allow for routine immediate implant placement given the greater risk of recession, implant exposure, implant malpositioning, inadequate initial implant stability, or reduced bone-implant contact. Examples of an EDS-3 defect include any socket with a buccal plate dehiscence of 7 mm from the reference point. Another example would include a tooth with interproximal bone or soft-tissue loss of 4 mm.

Extraction Defect — Type 4

The EDS-4 is characterized by a severely compromised socket with greater than 5 mm of vertical or trans-

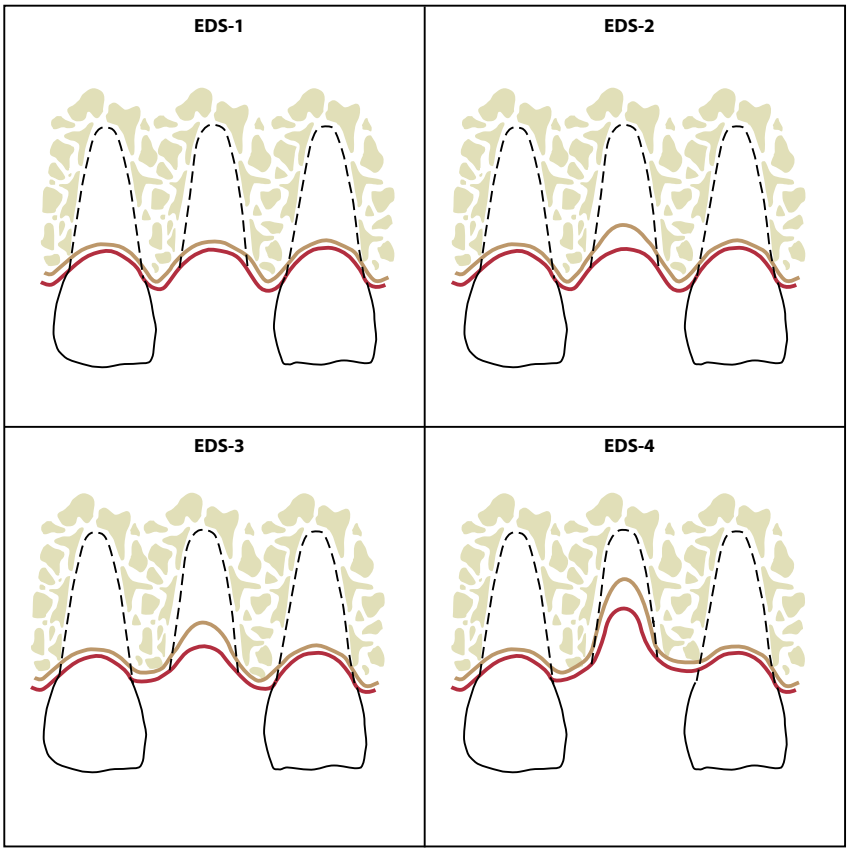


Diagram A. Illustration of the EDS defects.

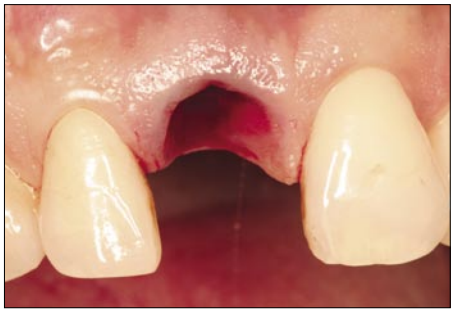


Figure 2a. Atraumatic microsurgical extraction of a fractured maxillary right central incisor.

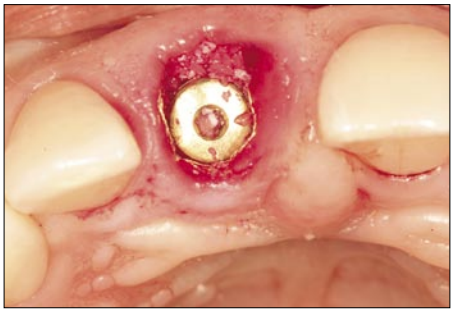


Figure 2b. Immediate implant placement is performed in this EDS-1 defect.

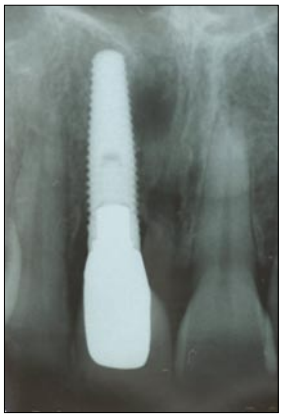


Figure 2c. Periapical radiograph one year following final insertion of the implant-supported crown.

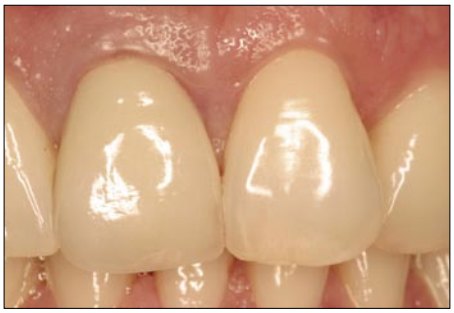


Figure 2d. Ideal soft-tissue esthetics is predictable in the EDS-1 defect. (Restoration by Glenn Bickert, DMD, Laguna Hills, Calif.)

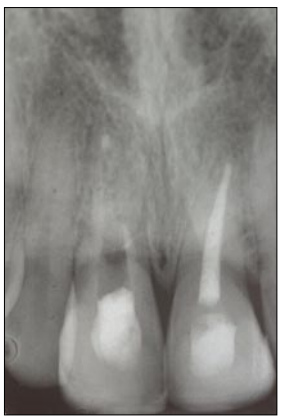


Figure 3a. Radiograph of a failing maxillary right central incisor.

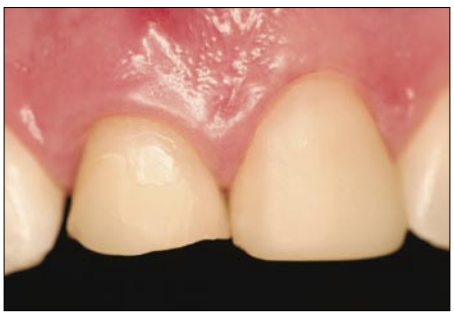


Figure 3b. A gingival fistula is present indicating a fenestration of the buccal alveolar plate.

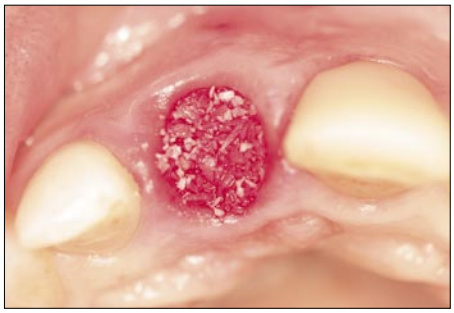


Figure 3c. Atraumatic extraction is followed by degranulation and irrigation of socket, and placement of a resorbable graft to assist in site preservation for this EDS-2 defect.

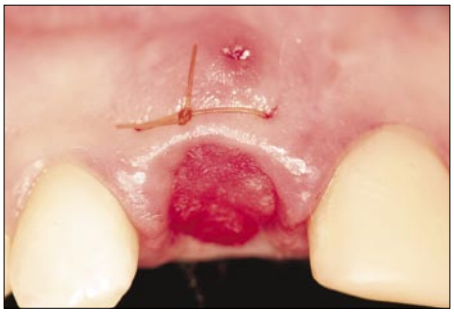


Figure 3d. A resorbable collagen membrane contains the graft and is secured with a single overlay suture.

verse loss of hard and/or soft tissue, two or more reduced socket walls in a systemically healthy individual. The periodontal biotype in these situations is either thick or thin. Immediate implant placement in these situations is not possible without compromised implant stability or significant amounts of implant body exposure. Examples of an EDS-4 defect include sites with an extensive history of periodontal pathosis leading to a severely reduced alveolar housing with destruction of the buccal and palatal plates. Another example would include greater than 5 mm of interproximal bone loss between multiple-tooth extraction sockets. With the surgical template in place, the distance between the gingival margin and the restorative cervical margin exceeds 5 mm. The alveolar crest is positioned greater than 8 mm away from this reference point.

Treatment Recommendations

The recommended treatment protocol for the EDS-1 is immediate implant placement following tooth extraction. Ideal soft-tissue esthetics are predictable (**Figure 2**). When immediate implant placement is beyond the surgeon's level of expertise or comfort zone, a two-stage approach is advised as described for the EDS-2.

The recommended treatment protocol for the EDS-2 is a two-step implant placement approach with site preservation techniques performed at the time of tooth extraction (**Figure 3**). An immediate implant with associated defect repair procedures when indicated can also be considered, however; a greater risk of recession and implant exposure may occur.[19,20] Site preservation involves atraumatic tooth extraction using periotomes or other microsurgical extraction instruments, thorough debridement of the socket including surgical manipulation to induce adequate bleed-

ing, augmentation of the socket with appropriate biomaterials in order to minimize alveolar resorption, and the use of resorbable membranes to contain the graft and reconstruct missing bony walls including the alveolar crest. In addition, an interpositional connective tissue graft should be considered whenever a soft-tissue deficit is present or a thin periodontal biotype exists in order to enhance soft-tissue thickness or compensate for the thin biotype where recession is anticipated. Implant placement follows three to six months later allowing for adequate wound healing and graft remodeling. Ideal soft-tissue esthetics is often achievable but not always predictable for the EDS-2.

The recommended treatment protocol for the EDS-3 is a two-step implant placement approach with site preservation techniques performed at the time of tooth extraction followed by implant placement three to six months later as described with the EDS-2 (**Figure 4**). A secondary procedure to perform site development may be necessary in some situations. Ideal soft-tissue esthetics is achievable but not predictable in the EDS-3. A slight esthetic compromise involving minor interproximal tissue loss or marginal recession can be expected with the final restoration.

The recommended treatment protocol for the EDS-4 is usually a three-step implant placement approach (**Figure 5**). Site preservation is performed at the time of tooth extraction as for an EDS-2 defect. Placement of a graft material serves to preserve the existing alveolus. A resorbable membrane is used to contain the graft and provide space for a modest regenerative response. The addition of a connective tissue graft will help enhance the soft-tissue profile and prepare for future primary closure during the subsequent second-stage regenerative procedure. A site development procedure then follows approximately three months later allowing for adequate wound healing. The defect prior to this procedure is a combination-type defect with a loss in both height and width. Multiple site development procedures may be necessary for this type of defect.[21] Alternatively, a defect repair procedure can occur concurrently with implant placement following the principles of guided bone regeneration.[20] However, the quantity of bone developed around the implant and degree of implant integration of this regenerated bone may be less predictable than a staged approach.[20,22] The use of autogenous bone for site development in either block or particulate form, or combination is preferable for these challenging defects.[23,24] When autogenous bone is used in particulate form, membranes are beneficial in order to stabilize the graft, preclude soft-tissue invagination and provide space for regeneration. A connective tissue graft is once again performed in order to enhance soft-tissue esthetics, as well as to minimize the risk of premature wound dehiscence and graft or membrane exposure. A three- to six-month healing period is required prior to the subsequent surgical procedure necessary for implant placement. Ideal soft-tissue esthetics is usually not achievable in the ED-4. A minor to moderate compromise involving modest interproximal tissue loss and/or marginal recession can be expected.

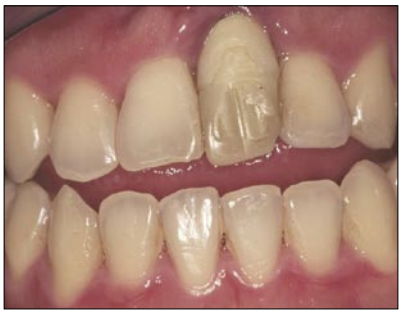


Figure 4a. Severe external resorption of the maxillary left central incisor.

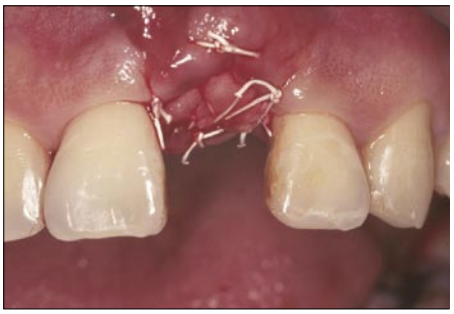


Figure 4b. A two-stage procedure is pursued including site preservation and development using a bone and soft-tissue graft for this EDS-3 defect.

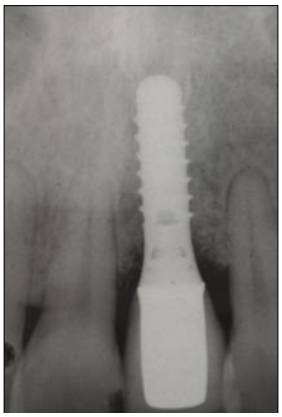


Figure 4c. Periapical radiograph one year following final insertion of the implant supported crown.

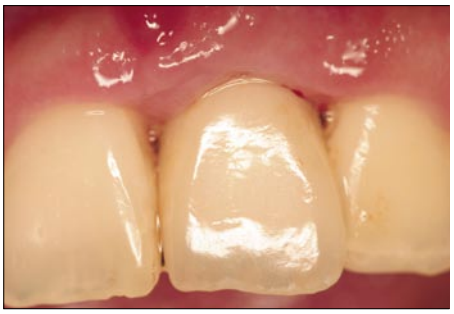


Figure 4d. Slight esthetic compromise of soft tissues with minor interproximal papilla loss can be expected in the EDS-3 defect. (Restoration by Monica Trieu, DDS, Irvine, Calif.)

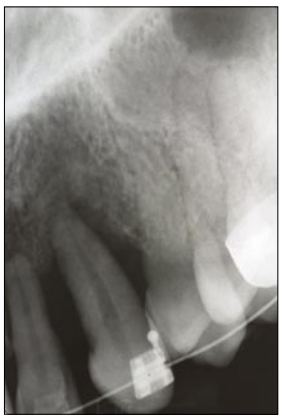


Figure 5a. Severe loss of alveolar bone around the maxillary left lateral incisor and canine associated with orthodontic extrusion of the previously impacted canine.

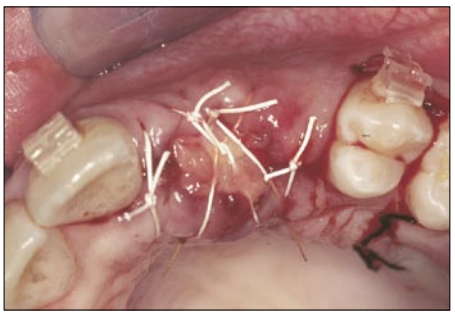


Figure 5b. A three-stage process is pursued for this EDS-4 defect. Site preservation is initially performed using a resorbable bone graft to augment the extraction socket and a connective tissue graft to expand the soft-tissue profile.

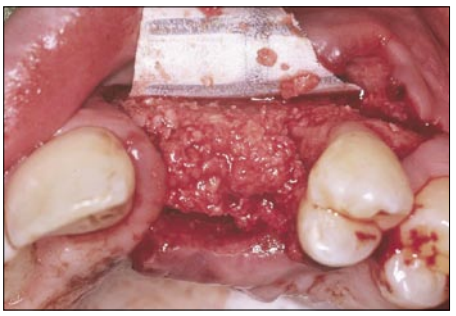


Figure 5c. A site development procedure is performed three months following the site preservation procedure using autogenous bone harvested from the symphysis, in conjunction with a space-providing e-PTFE membrane.

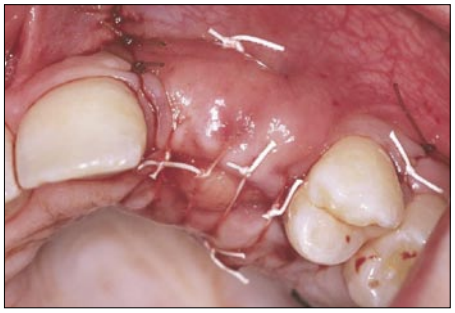


Figure 5d. A connective tissue graft is placed over the membrane prior to surgical closure to enhance the soft-tissue profile and reduce the risk of premature membrane exposure.

Figure 5e. Periapical radiograph following one year of function of the implant supported fixed partial denture.

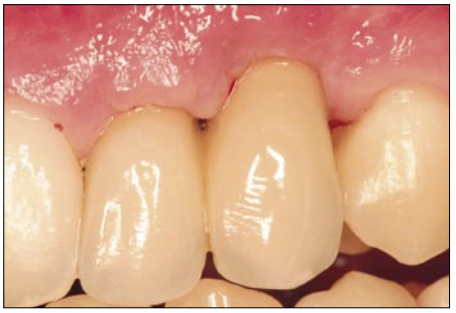


Figure 5f. Moderate esthetic compromise to soft tissues with minor interproximal papilla loss and gingival margin recession can be expected in the EDS-4 defect. (Restoration by Glenn Bickert, DMD, Laguna Hills, Calif.)

Prosthesis-Guided Tissue Healing

Following tooth extraction, classification of the defect and recommended treatment protocols, development and maintenance of esthetic soft-tissue architecture is essential. Interim prosthetic devices are useful in order to manipulate and guide soft-tissue healing and esthetics following tooth extraction and subsequent site preservation and development procedures (**Figure 6**). These devices include custom healing abutments and ovate pontic designs incorporated within fixed and/or removable interim prostheses.[16]

Ovate pontic designs are beneficial in preserving or establishing esthetic soft-tissue emergence profiles following site preservation or development surgery. After creating a master cast to fabricate the provisional, surgery is performed on the cast, removing the stone teeth to be extracted, and then creating a concavity within the model, partially simulating the extraction defects. Ovate pontics apply maintenance pressure on the gingival margin and interproximal papillae, minimizing the tissue collapse following tooth extraction. They can be incorporated within fixed as well as removable transitional restorations either chairside or in the laboratory using conventional acrylic or composite.

The ovate pontic surface should extend 2 to 3 mm within the extraction defect and apply facial but not apical pressure on the free gingival margin. It should only apply slight lateral pressure on the existing interproximal papillae and also provide room for coronal enlargement of the papilla to accommodate for inflammation. When removable provisionals are employed, they should include positive rest seats and adequate retention to prevent excessive compression of the extraction defect, augmentation materials and associated tissues.

Discussion

When implant dentistry is anticipated following tooth extraction, the clinician is faced with many choices. One option

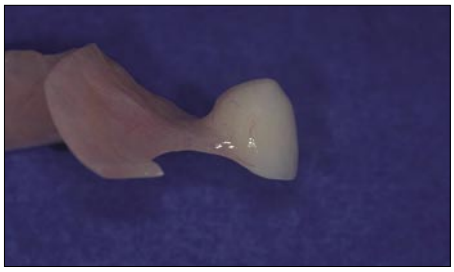


Figure 6a. Profile of a removable transitional appliance with an ovate pontic design.

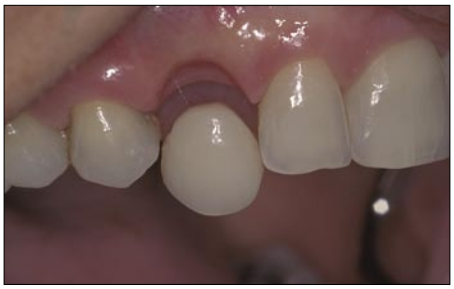


Figure 6b. An ovate pontic can guide tissue healing and help improve soft-tissue esthetics.

is to immediately place an implant into the fresh extraction socket.[7] Another option is to perform site preservation and then place the implant in a secondary procedure following healing.[10] A third option is to allow the socket to heal naturally, and then place the implant in a secondary procedure with associated fenestration or dehiscence-defect repair when necessary.[20] One final option is to perform site development to reconstruct the defect created due to physiologic socket healing and re-enter the site for the subsequent implant placement procedure.[23] In addition, extraction sockets are often damaged so extensively multiple augmentation procedures are necessary to adequately develop the site with ideal soft-tissue esthetics. The proposed extraction defect classification attempts to categorize the most common extraction defect presentations and simplify the treatment decision-making process.

Several alveolar defect classification systems have been previously reported and are in current use.[21,26,27] All of these existing classifications however, describe the condition of the hard and/or soft tissues of an already-healed edentulous site. A classification of the extraction defect immediately following tooth removal and prior to healing and remodeling which provides guidelines for implant treatment is currently not available.

The frequently used classification introduced by Seibert in 1983, and the less-commonly cited by Allen et al. in 1985, generally describes three types of clinical defects and presents treatment recommendations and techniques to predominantly improve the clinical soft-tissue deficit.[21,26] Treatment recommendations are proposed in order to enhance esthetics in preparation for conventional prosthodontics, including pontic sites. The three basic categories of defects reported by Seibert were subclassified by Wang in 2002 based on their size.[27] The authors offered therapeutic guidelines using their classification directed toward successful dental implant placement. The commonly referred to classifications by Lekholm and Zarb and Misch and Judy describe five and four degrees of alveolar resorption, respectively, following tooth extraction and physiologic remodeling. Soft tissues are not considered. Treatment recommendations are made directed toward successful implant placement and integration in addition to prosthetic treatment planning.[28,29] The preceding classifications all described an already-healed alveolus following tooth extraction and physiologic remodeling.

Salama and Salama proposed a similar classification to the one currently proposed in 1993.[11] The authors described various presentations of extraction defects or "environments" offering implant management guidelines. The authors distinguished between three types of extraction environments based on a subjective evaluation of the extent of bone and soft-tissue destruction classified as incipient, moderate, or severe. The authors recommended immediate implant placement with guided-tissue regeneration techniques if necessary for a Type I or incipient defect. They introduced the concept of orthodontic extrusion for a Type II or moderate defect and ridge augmentation for a Type III, or severely compromised defect. Since the Type II defect is an assessment prior to tooth extraction, at least part of their classification was based on pre-extraction tissue architecture. Further, the assessment techniques used to classify the defects were not presented as with the currently proposed classification.

The extraction defect sounding classification defines the condition of the hard and soft tissues immediately following tooth extraction, attempts to predict the wound healing response, and provides basic treatment guidelines to achieve predictable implant integration and esthetics. Treatment recommendations using this classification are conservative, focus on predictability of implant integration, and provide realistic esthetic expectations. This classification uses an objective method to evaluate the integrity of the hard and soft tissues immediately following tooth extraction using a periodontal probe in a manner often described as sounding, in conjunction with a prosthodontically derived surgical template used as a reference point.[30,18]

The EDS classification recognizes the varied wound healing response between thick and thin biotypes following surgical procedures.[14] The thick, flat periodontium is associated with short and wide tooth forms, and is characterized by short and flat interproximal papilla. The gingiva is thick and fibrotic with

wide zones of attached keratinized tissues and generally resistant to recession. Wound healing following extraction is ideal in these situations as described for the EDS-1 defect. Therefore, with an undamaged extraction defect, immediate placement can predictably yield ideal soft-tissue esthetics. In contrast, the thin, scalloped periodontium is usually associated with long and narrow tooth forms, and by long and pointy interproximal papilla. The gingiva is thin and friable with minimal amounts of attached keratinized tissues and thin underlying alveolar bone, which is frequently dehisced or fenestrated.

Following surgical procedures, marginal and interproximal tissue recession is common, as well as significant buccal plate alterations as described for the EDS-2 defect. Therefore, a two-stage approach is recommended and extra care urged when immediate implant placement is performed. When the integrity of the hard and soft tissues has been moderately compromised as described in the EDS-3 defect, either through periodontal or endodontic pathology or damaged during tooth removal, site preservation has been advised. When severe loss of bone and soft tissue will compromise the success of implant integration or create severe esthetic compromise, a process of site preservation followed by site development is often necessary as described for the EDS-4 defect.

Conclusions

Tooth extraction is a traumatic procedure often resulting in immediate loss of alveolar bone and soft tissues. A complex cascade of biochemical and histologic events occurs during the wound healing process, which further leads to physiologic alterations of the alveolar ridge. Therefore, site preservation involving atraumatic extraction techniques, application of biomaterials within the alveolar socket, including the use of membranes and soft-tissue grafts, should be considered an essential component of routine dental extraction surgery, especially in the esthetic zone.

A novel extraction defect classification system has been introduced. The EDS classification system describes the condition of the hard and soft tissues immediately following tooth removal, prior to healing and remodeling of the extraction socket, and provides basic treatment guidelines to achieve predictable implant integration and esthetics.

THE EDS CLASSIFICATION SYSTEM FOCUSES ON THE PREDICTABILITY OF IMPLANT INTEGRATION AND ESTHETICS, AND IS CONSERVATIVELY BASED WITH RESPECT TO TREATMENT RECOMMENDATIONS.

The EDS classification system focuses on the predictability of implant integration and esthetics, and is conservatively based with respect to treatment recommendations. This classification uses an objective method to evaluate the integrity of the hard and soft tissues immediately following tooth extraction using a periodontal probe in conjunction with a prosthetically derived surgical template used as a reference point. Extraction defect management guidelines are based on the alveolar and soft-tissue architecture, the periodontal biotype, systemic condition of the patient, realistic esthetic expectations, and the most predictable way to treat the particular situation using dental implants. CDA

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BILAMINAR SUBEPITHELIAL CONNECTIVE TISSUE GRAFTS FOR IMMEDIATE IMPLANT PLACEMENT AND PROVISIONALIZATION IN THE ESTHETIC ZONE

Joseph Y.K. Kan, DDS, MS; Kitichai Rungcharassaeng, DDS, MS; and Jaime L. Lozada, DDS

ABSTRACT

Immediate implant placement and provisionalization has been considered as a preservative procedure when replacing failing teeth, especially in the esthetic zone. Nevertheless, an average facial gingival tissue recession of 1 mm is still common after one year of function. Furthermore, facial gingival recession of thin periodontal biotype seems to be more pronounced than that of thick biotype. Biotype conversion around both natural teeth and implants with subepithelial connective tissue graft has been advocated, and the resulting tissues appear to be more resistant to recession. A technique combining subepithelial connective tissue graft and immediate implant placement and provisionalization is devised to achieve a more stable peri-implant tissue in thin biotype situations. This article describes the surgical and prosthodontic approach of this procedure as well as its clinical rationale.

Esthetics has been a dominating force in dictating the direction of development in implant dentistry for the past decade. Esthetics in implant dentistry encompasses not only the natural-looking restorations, but also the unaltered states of the surrounding tissue architecture.[1] Papilla loss, black triangles, facial tissue recession, etc. are the terms used to describe esthetically challenged situations. Studies had been conducted to identify the etiologies of



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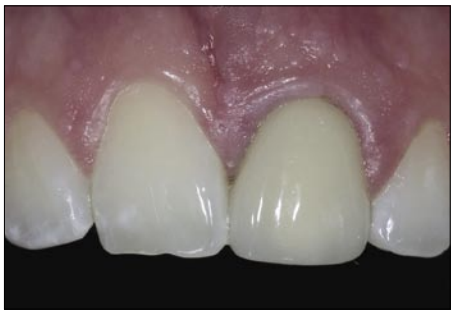


Figure 1. Pretreatment view of the failing tooth No. 9 (left maxillary central incisor) due to external root resorption. Note the high gingival scallop and thin tissue biotype.

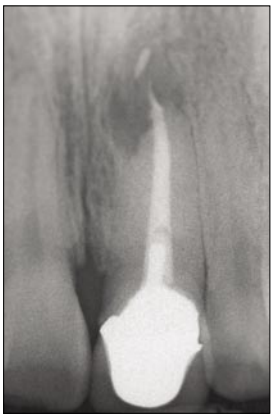


Figure 2. Periapical radiograph shows external root resorption of the apex of tooth No. 9.

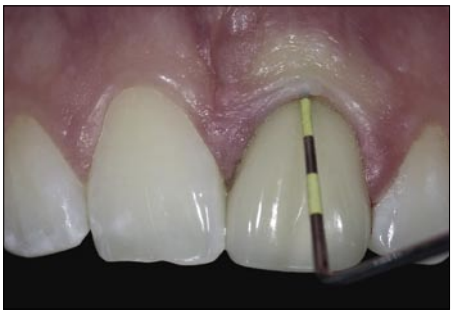
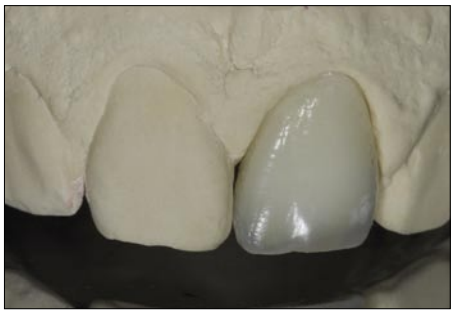
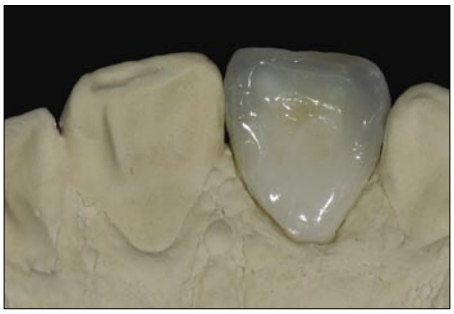


Figure 3. Facial dentogingival complex dimension of 3 mm was verified using bone-sounding technique. Since the free gingival margin of the failing tooth (No. 9) was also more coronal to that of the contralateral tooth (No. 8), immediate tooth replacement was indicated in this situation.





Figures 4a and b. Customized provisional restoration was fabricated in the laboratory prior to the surgery.

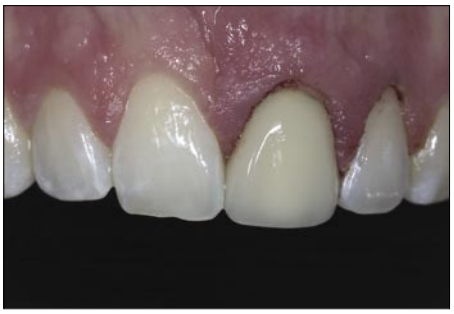
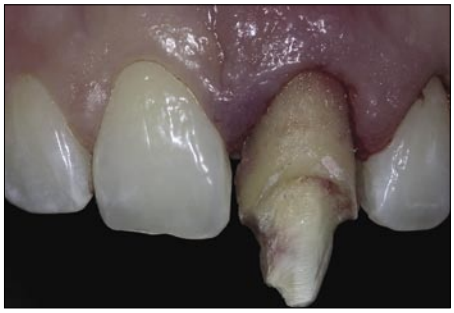


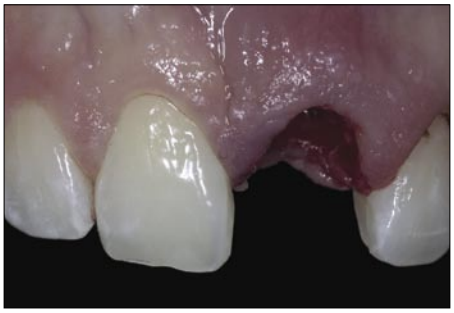
Figure 5. Minor soft tissue recontouring (gingivoplasty) was performed on teeth Nos. 9 and 10 to create harmonious gingival architecture with surrounding dentition.

tissue loss and techniques developed to prevent or minimize its occurrence.[2,3] The concept of tissue preservation has, therefore, been advocated and extensively used to enhance the esthetic outcome. This concept entails immediate implant placement and provisionalization where osseous architecture is preserved by immediate implant placement and soft tissue architecture is maintained with immediate provisionalization.[4-6]

The success of this concept, however, is influenced by a number of factors that can be identified as extrinsic or intrinsic. Extrinsic factors include proper 3-D implant position and angulation, as well as appropriate contour of the provisional restoration.[7] These factors are clinician-dependent and guidelines regarding these issues have been established and satisfactory outcome reported.[2] Intrinsic factors, on the other hand, are patient-dependent and therefore, can be favorable or unfavorable. These factors include bone level, hard and soft tissue relationship, bone thickness, and soft tissue biotype.[7] Conversion of unfavorable traits to favorable ones is vital to achieving esthetic outcome. Bone level and hard and soft tissue relationship are usually proactively modified via orthodontic and/or periodontic treatment prior to, while bone thickness may be enhanced by bone grafting simultaneously with immediate tooth replacement procedure.[5] The propensity to recession after surgical insults of thin gingival tissue has been validated and reconstructive procedures (free gingival or connective tissue grafts) are usually the treatment of choice for natural teeth with receded gingiva. However, these reconstructive procedures have not been shown to be predictable for their implant counterpart. On the other hand, successful tissue enhancement had been reported when connective tissue graft was performed at the time of implant placement or abutment connection.[3,8,9] Nevertheless, connective tissue graft at the time of immediate tooth replacement had not been reported.

This article describes a technique of gingival tissue enhancement using





Figures 6a and b. Atraumatic tooth extraction resulting in a well-preserved gingival architecture.

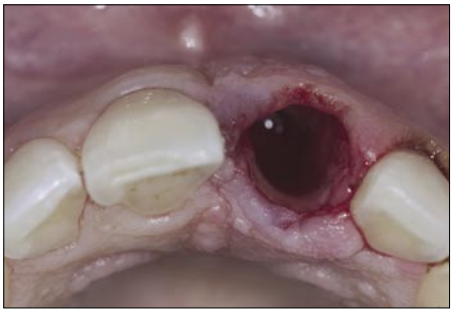


Figure 7. Occlusal view of the extraction showing thin facial gingival tissue.

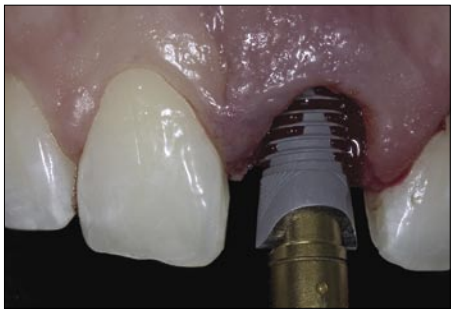


Figure 8. An implant (NobelPerfect Groovy, Nobel Biocare) was placed immediately in the extraction socket without flap reflection.

bilaminar subepithelial connective tissue graft, SCTG, in conjunction with immediate implant placement and provisionalization in the esthetic zone.

Case Presentation

Case 1

A 28-year-old female patient presented with external root resorption of the maxillary left central incisor, No. 9, and had been advised that the tooth should be extracted (**Figure 1**). Radiographic and clinical evaluations showed no signs or symptoms of active infection (**Figure 2**). Periodontal evaluation revealed a thin and scalloped periodontium. Bone sounding measurement of 3 mm at the facial aspect of tooth No. 9 revealed a normal osseous/gingival tissue relationship (**Figure 3**).[10] Furthermore, the facial free gingival margin of tooth No. 9 was more coronal than that of the contralateral tooth No. 8. After discussing the risks and benefits with the patient, she agreed to having bilaminar SCTG in conjunction with immediate tooth replacement as her final treatment.

Presurgical Procedures

Fabrication of Provisional Restoration

A preliminary impression was made using vinyl poly-siloxane (Reprosil, Dentsply International Inc., Milford, Del.) and diagnostic casts were fabricated with Type III dental stone (Microstone, Whip Mix Corp., Louisville, Ky.). A diagnostic waxing of the failing tooth was executed to match the contralateral tooth. The cast was duplicated and a silicone matrix (Sil-Tech, Ivoclar North America Inc., Amherst, N.Y.) was made. The to-be implanted tooth on the cast was then under-prepared with a 1 mm subgingival margin. The silicone matrix was used as the guide to form the contour of the acrylic resin provisional shell (Vita Zeta, Vident, Brea, Calif.). The finished provisional shell was then disinfected for the implant surgery (**Figure 4**).

Surgical Procedures

Immediate Implant Placement

At the time of surgery, gingivectomy with an inverse bevel incision and transeptal fiberectomy was performed around Nos. 9 and 10 to create a harmonious gingival architecture with the surrounding dentition (**Figure 5**). Subsequently, the failing tooth was removed atraumatically with the aid of a periotome (Nobel Biocare, Yorba Linda, Calif.) while preserving the gingival architecture (**Figures 6 and 7**). An implant (NobelPerfect Groovy, Nobel Biocare) was then placed immediately in the extraction socket without flap reflection (**Figure 8**). Primary implant stability was achieved by engaging the palatal wall and the bone 4 mm to 5 mm beyond the apex of the extraction socket. The implant-prosthetic platform was placed 3 mm from the predetermined gingival margin.

Recipient Site (Bilaminar Envelope) Preparation

An intrasulcular incision was made with a surgical blade (No. 15c, Kai, Japan) on the labial aspect of tooth No. 9 creating an initial separation between the gingival from the underlying bone. A curette (Younger-Good 7/8 curette, Hu-Friedy, Chicago, Ill.) was then used to further separate the gingiva from the bone extending to the mucogingival junction. A partial thickness sharp dissection was made apically and mesiodistally (No. 1/2 Orban DE knife, Hu-Friedy) leaving the underlying periosteum in place, while releasing residual flap tension that facilitated passive coronal displacement of the flap.

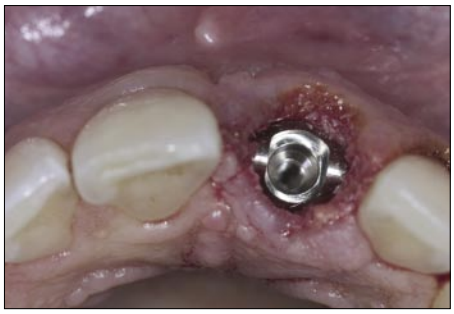


Figure 9. A bilaminar envelope was created to receive the subepithelial connective tissue graft before the bone grafting material was placed in the gap between the implant and the facial plate.

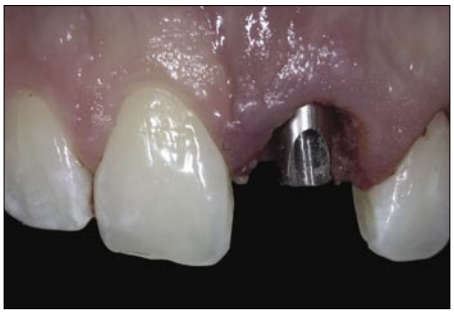


Figure 10. An abutment (Nobel Perfect Groovy 10-degree Abutment) was hand tightened onto the implant.

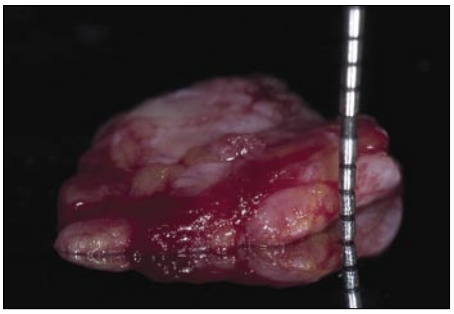


Figure 11. Connective tissue graft with a minimal vertical length of 9 mm, 2 mm in thickness, and the width consistent with the mesiodistal width of the recipient site was harvested from the palate.

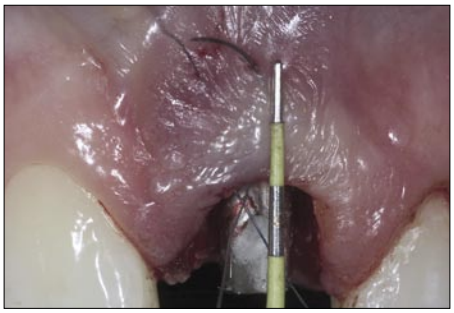
The gap between the implant and facial bone plate was then filled with xenograft (Bio-Oss, Osteohealth Co, Shirley, N.Y.) (**Figure 9**).

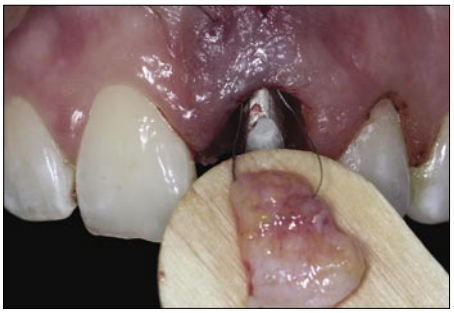
Finalization of Abutment and Provisional Restoration

An abutment (Nobel Perfect 10-degree abutment, Nobel Biocare) was placed onto the implant for the reception of the previously prepared provisional shell. The provisional shell was relined with light polymerizing acrylic resin (Revolution Formula 2, Kerr, Orange, Calif.) and was adjusted to clear all centric and eccentric contacts. The abutment-provisional restoration assembly was refined extraorally to ascertain optimal fit. The abutment was then hand tightened onto the implant (**Figure 10**) and the site was prepared for SCTG.

Harvesting Connective Tissue Graft

The SCTG with a minimal dimension of 9 mm in length, 1.5 mm in thickness, and the width consistent with the mesiodistal width of the recipient site was harvested from the palate utilizing a single-incision technique (F**igure 11**).[11] A single incision was made to the bone with a surgical blade (No. 15, Kai) orientated perpendicular to the palatal tissue in a horizontal direction approximately 2 mm to 3 mm apical to the gingival margin of the maxillary teeth. A partial thickness sharp dissection was made parallel to the long axis of the teeth, leaving the graft attached to the underlying bone, while maintaining an adequate thickness of the overlying palatal flap to minimize sloughing. The connective tissue with the underlying periosteum was then elevated and dissected from the palate with the use of the combination of suture pliers (Corn Suture Pliers, Hu-Friedy), an elevator (Buser Periosteal Elevator, Hu-Friedy), and surgical blade (No. 15, Kai). After removal of the adipose tissue, the harvested graft was maintained in a moist environment to prevent desiccation prior to its placement. Primary closure of the donor site was attained using resorbable sutures (P-3 5-0 Vicryl, Johnson & Johnson Ethicon, England).

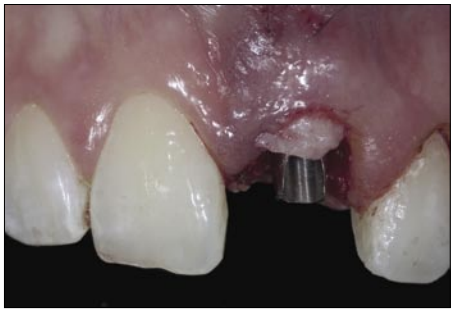


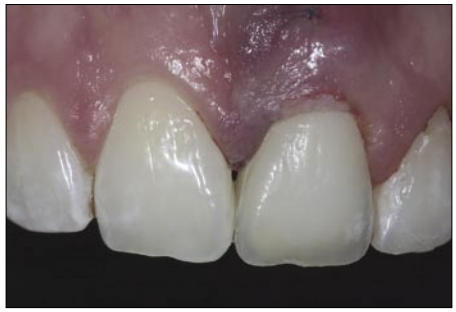


Figures 12a and b. After the abutment placement, the suture needle was passed through the outer surface of the prepared envelope ~6 mm from the free gingival margin and ~3 mm vertically and 2 mm horizontally from one end of the SCTG.

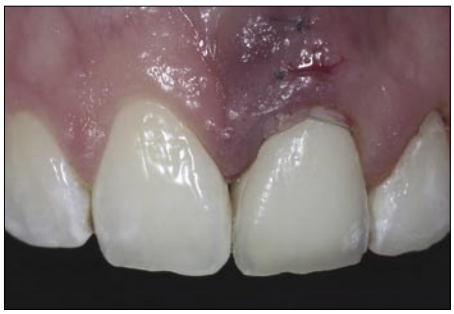
Placement of Graft and Provisional Restoration

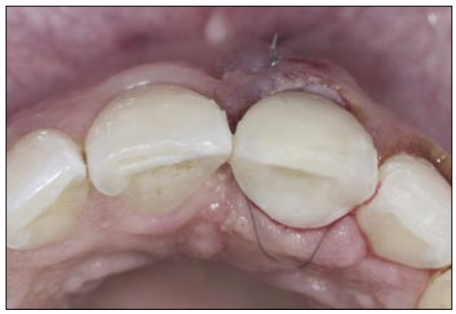
The suture needle (S14 6-0 Chromic gut blue, Johnson & Johnson Ethicon) entered the outer surface of the prepared envelope ~6 mm from the free gingival margin (**Figure 12a**). While the graft was being secured with the suture pliers (No. 20 Corn Suture Pliers, Hu-Friedy), the needle was passed through its de-epithlialized surface from one end ~3 mm vertically and 2 mm horizontally (**Figure 12b**). Once exited, the needle gained entry through the periosteal surface of the graft at the same vertical





Figures 13a and b. The SCTG was gently drawn into the envelope simultaneously with the placement of the provisional restoration.





Figures 14a and b. A cross-sling suture was placed at the coronal aspect of the envelope flap to secure the flap over the graft. Both gingival tissue height and thickness were enhanced with this procedure.

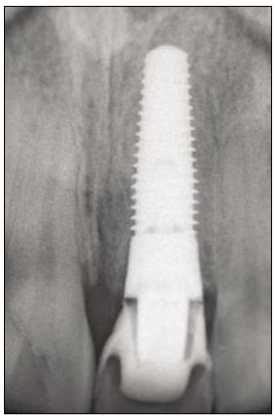


Figure 15. Postoperative periapical radiograph of implant No. 9.

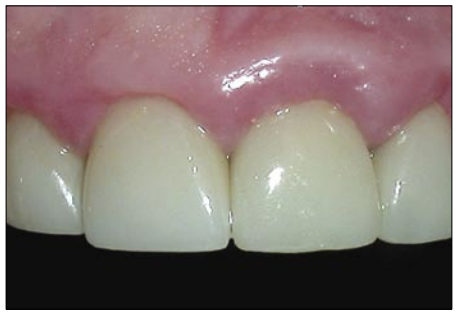


Figure 16. Pretreatment view of the failing tooth No. 9 (left maxillary central incisor) due to endodontic failure.

position but ~2 mm from the other end of the graft horizontally. Finally, the needle exited through the envelope at the same vertical position as the entry point while maintaining the horizontal distance between the entry and exit points of ~3 mm (**Figures 12a and b**).

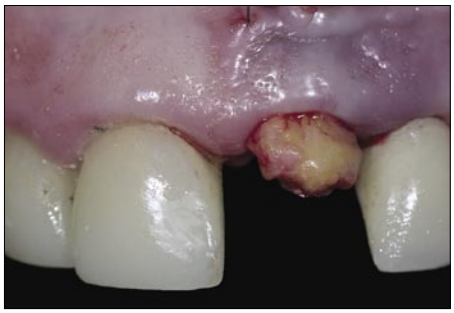
The SCTG was drawn in the prepared envelope with the periosteal side of the graft facing the osseous surface of the recipient site simultaneously with the cementation (Temp-bond, Kerr USA, Romulus, Mich.) of the provisional restoration (**Figures 13a and b**). The amount of cement used should be minimal and mostly isolated at the intaglio incisal and lingual area of the provisional for the ease of cement removal. A cross-sling suture was placed at the coronal aspect of the envelope flap to secure the flap over the graft (**Figures 14a and b**). Light finger pressure was then applied over the grafted site with moist gauze for five minutes to minimize blood clot formation between the graft and its underlying and overlying tissues. Periapical radiograph was made to ascertain the fit of the prosthesis (**Figure 15**).

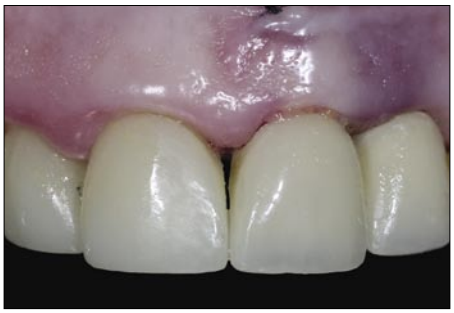
Postoperative Instruction

Appropriate antibiotic and analgesics were prescribed for postoperative use. The patient was instructed not to brush the surgical site, but to rinse gently with 0.12 percent chlorhexidine gluconate (Peridex, Procter & Gamble, Cincinnati, Ohio), and be on a liquid diet for two weeks. A soft diet was recommended for the remaining duration of the implant healing phase (four months). The patient was also advised against functioning or activities to the surgical site. The final restoration has not been placed at the time of this publication.

Case 2

A 57-year-old female patient presented with endodontic failure of the maxillary left central incisor, No. 9, (**Figure 16**). The tooth was extracted and bilaminar SCTG in conjunction with immediate tooth replacement was initiated (**Figures 17a and b**). The final implant impression was made approximately four months following the SCTG and implant surgery using vinyl poly-siloxane (Reprosil, Dentsply International Inc.). The abutment was torqued to 35 Ncm (manufacturer's recommendation, Nobel Biocare) and the definitive restoration was cemented (**Figure 18**).





Figures 17a and b. The SCTG was gently drawn into the envelope followed with the placement of the provisional restoration.

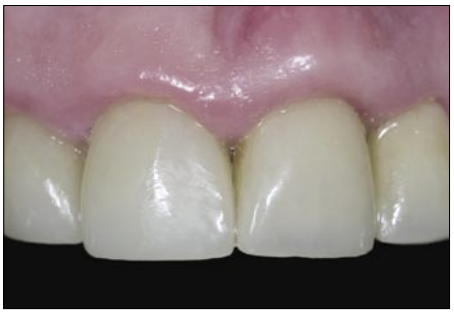


Figure 18. Facial view of the definitive restoration.

Discussion

Thin biotype and non-keratinized gingiva around natural dentition possess an inherent risk of recession when subjected to surgical, restorative and/or mechanical trauma.[12,13] Interestingly, a similar phenomenon can also be observed on peri-implant mucosa.[14] In studies that involved immediate implant placement and provisionalization procedures (one-stage), an average of 1 mm of facial gingival recession had been reported one-year following the surgery.[2,3] However, these studies did not attempt to correlate the amount of recession to different gingival biotype. Nevertheless, bone-sounding measurements around two-stage implants revealed that thin gingival biotype is associated with significantly lesser peri-implant mucosa dimension than that of thick biotype, indicative of its propensity to tissue recession.[15] According to these results, it is logical to deduce that thin biotype may lead to greater gingival recession following immediate tooth replacement. Under such circumstances, to minimize gingival recession from implant surgery, one of the objectives should be to increase the quality and quantity of the gingival tissue via gingival grafts. SCTG with mucogingival bilaminar flaps on natural dentition had been shown to be effective in significantly increasing the thickness of the marginal gingival tissue as well as the width of the keratinized tissue.[13,16-21] Furthermore, gingivoplasty after the healing of SCTG has been recommended to improve the esthetics and increase surface keratinization.[22-25] However, the occurrence of surface keratinization after gingivoplasty has not been consistently confirmed.[20] It has been postulated that surface keratinizatiton may be induced by the genetic potential of the subepithelial connective tissue graft or the migration of the surrounding epithelial cells.[19,21,26,27]

Partial thickness sharp dissection is often recommended when preparing the recipient site envelope flap as it may enhance initial revascularization of SCTG.[24,28] When comparing the healing of free gingival grafts placed in a recipient bed of either denuded bone or bone with retained periosteum, Caffesse et al. showed that denuded cortical bone underwent initial resorption, delaying vascular proliferation and thus compromising early stages of healing.[29] On the other hand, Nelson reported excellent clinical results even though full thickness flaps were used to cover connective tissue grafts.[30] Despite the conflicting data, in the authors' opinion, partial thickness site preparation is preferred as initial revascularization may be critical for grafting around nonvascularized implant surface. Nevertheless, making a partial thickness sharp dissection on thin and friable gingiva is technique-sensitive and risk of perforation resulting in tissue necrosis is high.[24] Under such circumstances, full thickness blunt dissection is recommended to develop the initial access to the recipient envelope; from the free gingival margin to the mucogingival junction. Beyond that point, the gingival tissue is usually thicker, and a partial thickness sharp dissection can be achieved.

The size of the SCTG for implant gingival biotype conversion is usually larger than that for natural teeth root coverage. In this article, it is the authors' opinion that the harvested graft should have a minimal vertical height of 9 mm, a horizontal width consistent with the mesiodistal width of the recipient site, and a minimal thickness of 1.5 mm. The recommended distance between the facial gingival and its underlying bone for immediate implant placement and provisionalization is 3 mm.[7] Under such circumstances, a vertical tissue graft height of 9 mm will allow for a minimal of 6 mm of the graft to be contained within vital bone and periosteum to ensure graft survival. A graft width consistent with the mesiodistal width of the recipient site will enhance gingival emergence esthetics. Finally, clinicians have advocated a minimal graft thickness of 1.5 mm for easy of handling and minimal graft

shrinkage following surgery.[31,32]

Spaces present between the graft and its overlying and underlying recipient flaps had been suggested to be the culprit for graft failures.[33] These dead spaces harbor thick blood clots that potentially hinder the anastomosis of new capillary buds from the recipient bed, thus jeopardizing the graft survival.[34] Therefore, it is recommended that pressure be applied with moistened gauze at the grafted site for a minimum of five minutes to facilitate hemostasis and minimize blood clot thickness.[24] In addition, a cross-sling suture placed at the coronal aspect of the envelope flap may assist graft immobilization further enhancing graft success.

Since the buccal bony plate underneath the thin gingival tissue is also generally thin and prone to fracture, extraction, flap management as well as SCTG placement, must be performed with extreme care. Bone grafting material placed in the gap between the implant and the buccal bony plate prior to flap manipulation and SCTG may help minimize the risk.

Conclusions

Based on short-term clinical follow-up, besides being able to maintain existing osseous and gingival architecture, bilaminar subepithelial connective tissue graft simultaneously with immediate implant placement and provisionalization also improved gingival quality and quantity. This is especially advantageous to the thin periodontium, where, without the gingival graft, greater tissue recession is likely to occur. Nevertheless, this technically demanding procedure, with variables that are still not conclusive, warrants additional studies. Furthermore, although the favorable initial results reported with this treatment modality might suggest it as a viable and predictable treatment option, careful patient selection, and treatment planning are still as important as or even more important than the treatment itself. CDA

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ESTHETIC THERAPY WITH STANDARD AND SCALLOPED IMPLANT DESIGNS: THE FIVE BIOLOGIC ELEMENTS FOR SUCCESS

Sascha A. Jovanovic, DDS, MS

ABSTRACT

The field of implant dentistry has grown significantly in recent years. Balancing natural-looking esthetics with long-term function, however, remains a challenging task. The main focus of implant dentistry is on improving the survival rate, simplifying the treatment, improving the esthetic outcome, and reducing the treatment time. Developing a natural contour and anatomically dimensioned soft-tissue margin is critical to attaining an esthetic implant restoration. This article discusses the five elements to achieve natural implant esthetics: bone foundation, implant design and placement, soft-tissue profile, prosthetic tissue support, and ceramic art design.

Endosseous implant design has remained relatively consistent since its introduction to the dental profession by Per Ingvar Brånemark and demonstrated a remarkable success rate and longevity.[1] Since then, the focus of implant dentistry has been on the improvement of the survival and success rate, simplification of the treatment, improvement of the esthetic outcome, and reduction of the treatment time.[2-6] To cope with the high esthetic demands of today's patient population, new concepts and components were developed.

New abutment designs in combination with the original implant fixtures and implants resembling the anatomy of the natural roots have been introduced.[7] But in a five-year study, Jemt reported he still found only 60 percent of the cases with full gingival support and the other 40 percent had incomplete papillae, long crowns, and recession of the soft tissue.[8] This was often caused by implants being placed too deep or tissues being lost during the functional phase.

On evaluation of the esthetic outcome with dental implants designed for the absorbed ridge of the totally edentulous patient, several areas required change in order to improve the quality of implant esthetics in the partially edentulous patient: 1) the understanding of the effect of the biologic soft-tissue width on the implant and transgingival component; 2) the implant position in relationship to the surrounding bone foundation; 3) the bone apposition (osseointegration) area around the abutment-implant interface; and 4) the abutment materials utilized in the transgingival area.

Biologic Soft-Tissue Challenge

This clinical challenge was revisited through an analysis of the biological tissue responses around the implant body and neck, the abutment, and the soft-tissue space. Around natural teeth, three

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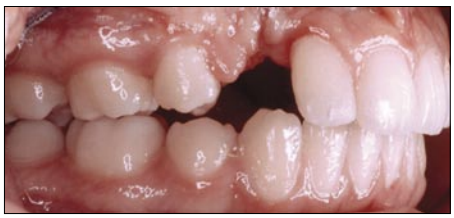

Figure 1. Buccal view of severe localized tissue loss after unsuccessful orthodontic extrusion of impacted canine.

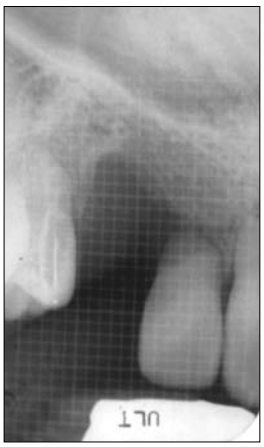

Figure 2. Radiograph demonstrating the loss of vertical and horizontal bone and resorption of adjacent roots.

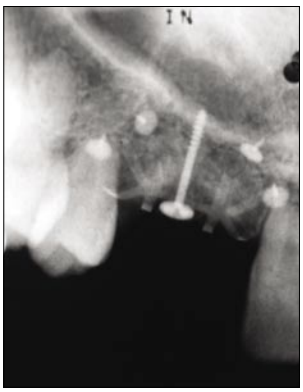

Figure 3. Radiograph showing the vertical bone augmentation treatment with autogenous bonegraft and a TR-PTFE membrane after removal of the hopeless lateral incisor.

distinct compartments, sulcular depth, junctional epithelium, and connective tissue, form a predictable and stable periodontal attachment.[9] This comprehensive biologic structure is known as the biologic width, a term that has been used in periodontal literature since the 1960s. Stable soft tissues, a reflection of osseous supporting structures, are required around natural teeth as well as dental implants, and these form the basis for an esthetically pleasing implant restoration. It has been shown that the principles of biologic width are also valid around dental implants.[10,11] The tissue compartments around endosseous implants have similar dimensions resulting in 3 mm to 4 mm of total soft-tissue height.

In long-term studies with totally and partially edentulous patients using one- and two-stage implants, approximately 0.7 mm to 1.5 mm of bone remodeling was observed during the first year, with subsequent bone loss of 0.1 mm per year.[1,11-13] The remodeling of the crestal bone around an implant is multifactorial; it depends on the vertical location of the implant-abutment interface in relationship to the bone and the state of the implant surface (smooth versus roughened surface).[14] Placing the prosthetic table deeper into the bone (countersinking) results in increased bone loss compared to a more coronal placement. In two-stage systems, which are placed at or below bone level, the frequent exchanges of components (healing abutment, temporary restorations, impression copings, try-in of frameworks) can significantly disturb the epithelial and connective tissue layer and allow for apical migration of all tissue compartments resulting in increased bone loss.[15,16]

Implant Position Challenges

Following tooth loss, the resorption of the residual ridge transforms a 3-D osseous structure into a ridge with a flattened topography.[17] In healthy patients, soft-tissue contours closely follow the underlying osseous structures forming a complete interproximal gingival papilla.[18,19] The final vertical position of an implant neck into a scalloped ridge or an extraction site can be a significant challenge as a deep or shallow position can compromise either interproximal bone or expose the buccal surface of an implant. Another consequence can be deep implant placement when working with a resorbed, flattened ridge. Additional, subgingival prosthetic manipulation may result in tissue inflammation and eventual bone resorption and, therefore, compromise long-term osseous support for the soft tissue.[14-16]

The fundamental requirement for the attainment of an esthetically pleasing implant supported restoration is the establishment of an ideal vertical implant position, which is in harmony with the surrounding bone and the soft-tissue thickness.[5] The main factors determining the vertical position relate to implant design, implant surface, and expected bone remodeling around the implant. Studies evaluating bone remodeling around dental implants show bone remodeling ranging from 0.7 mm to 1.5 mm.[1,11-13,20] This anticipated bone loss should be subtracted from the total peri-implant soft-tissue space of 3 mm to 4 mm. This results in an ideal position of the implant neck 2 mm to 3 mm apical to the lowest point of the desired buccal marginal gingiva.[5]

The bone crest must be located within 3 mm to 4 mm on the facial and 5 mm in the interproximal area to accomplish the required height of the free gingival margin and the interproximal papilla for the final restoration.[5,21,22] A dense keratinized tissue present (thick,

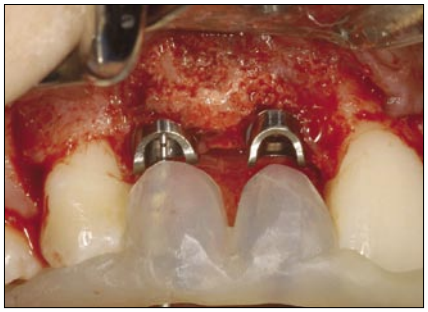

Figure 4. Buccal view of complete vertical bone regeneration after nine months of uneventful healing. Note the optimal vertical position of the implants 2 mm below the gingival margin of the surgical guide stent.

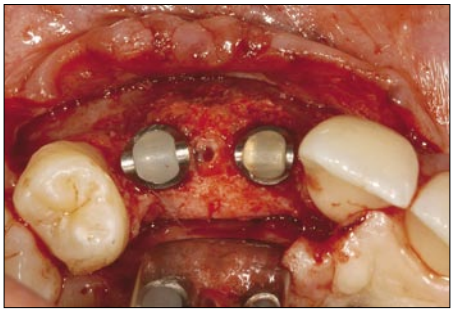

Figure 5. Occlusal view of complete horizontal bone regeneration and the optimal buccal lingual placement of the implants.

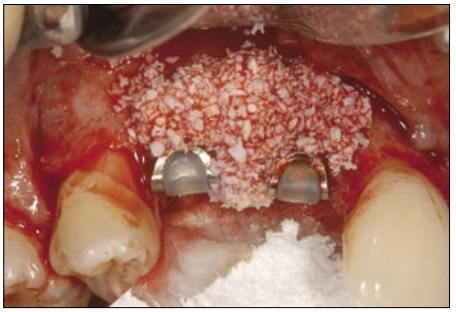

Figure 6. Secondary bonegraft placement with bovine deproteinized HA and a resorbable membrane supporting the soft tissues.

fibrotic tissue vs. thin, highly scalloped tissue) is preferred to establish stable soft-tissue margins.

Esthetic vs. Biologic Challenges

For optimal esthetics, the implant should be placed as deep as biologically acceptable, while at the same time the abutment-implant should be kept away from the bone to minimize tissue trauma which would lead to remodeling. For prosthetic reasons and proper emergence profile, a minimum of 2 mm and a maximum of 4 mm from the implant prosthetic table to the future tissue emergence are required. This shallow depth is possible when an adequate soft-tissue thickness is present. Prosthetic biomaterials in the subgingival space influence the health and stability and therefore ceramic and titanium materials of normal or undersized dimensions are preferred.[14-16]

Bone Foundation: 3-D Bone Grafting for Esthetic Soft-Tissue Support

Esthetic bone grafting to the implant site is indicated if the distance between the osseous crest and the desired future free gingival margin is more then 4 mm. This advanced implant therapy has produced good results with bone grafts, GBR-procedures, and alveolar distraction osteogenesis. The surgical procedure needs to be executed with the utmost care in order to preserve maximum vascularity to the flap and the underlying bone. One of the treatment options is to use a GBR procedure with autogenous bone or a combination of autogenous and filler bone grafts covered with a barrier membrane.[23,24] This allows for the controlled regeneration of osseous structures in both horizontal and vertical directions. When using an implant, this technique may be used to recreate lost bone dimensions or enhance the overall horizontal and vertical dimension of the skeletal tissue. It is recommended to reconstruct the missing alveolar bone in a two-stage bone regeneration procedure unless the bone loss is moderate and mainly needs buccal augmentation. A two-stage bone regeneration procedure will minimize the risk of exposure of the bone graft material and/or the implant neck if soft-tissue problems occur during the healing period.

Bone Graft Material of Choice

According to published reports, autogeneous bone is the golden standard as a grafting material.[25] The use of autograft is characterized by excellent biocompatibility, no risk of disease transmission, excellent space monitoring properties, and an osteoconductive scaffold for osteoblasts during the bone formation period. However, harvesting of the graft material complicates and prolongs the surgical procedure, and there is always a risk of donor site morbidity. The autograft removal, particularly from the chin area, can induce short to medium term paresthesia in the mandibular anterior dentition. Therefore, the mandibular ramus is preferred as a donor site. A frequently utilized harvest technique is the removal of bone from the external oblique ridge with the "Audi" trephine method or using a bone scraper.[26] Bone from the tuberosity, the lower portion of the nasal aperture, or any endentulous area is generally used for smaller graft volumes. A cortical bone graft from the ramus will result in the slowest amount of bone turnover, whereas osseous coagulum collected from the implant drill procedure and tuberosity bone will result in the highest amount of bone resorption. The use of other bone graft materials has also been proposed. Application of allografts and bovine HA-grafts has been demonstrated to be

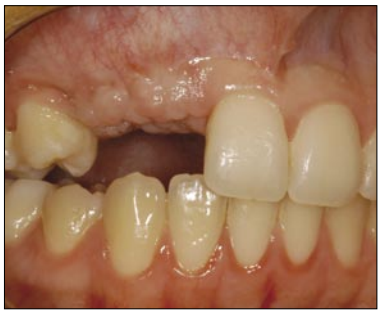

Figure 7. Uneventful healing of bonegraft and implant site.

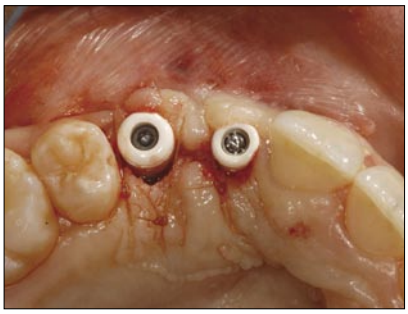

Figure 8. Occlusal view of minimal invasive uncovering procedure after four months of healing and attachment of healing abutments.

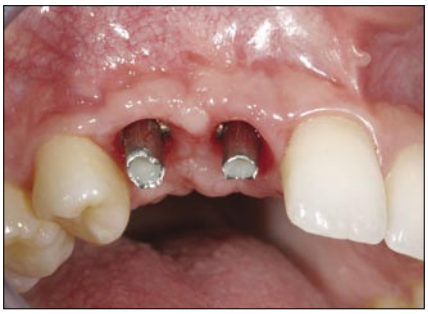

Figure 9. Prosthetic posts which were attached on same day of uncovering and used to support temporary prosthesis.

successful, but long-term results in the treatment of largely exposed implant surfaces and ridge defects with these types of grafts are not yet available. A safe treatment modality is the layering bone graft technique in which the exposed implant surface or the critical bone deficient area is first grafted with autogenous bone material while the outer periphery of the defect is grafted with a bone filler material.

Implant Design: Design and Surface Improvements

Elimination or reduction of bone remodeling and maintenance of present or regenerated bone is the ultimate motive for designing and using dental implants with a biologic neck design in esthetic implant therapy.[25,26] An appropriately designed implant body and neck uses an enhanced surface to develop an optimal bone apposition area which is osteoconductive and allows for bone apposition and soft-tissue stability.[20] Two new implant concepts are presently used: 1) a scalloped implant with interproximal higher margins and 2) a flat-top implant neck with an enhanced, roughened surface placed at the bone level and an abutment material, design and utilization which respects the soft and hard tissue. Both implant concepts are indicated for the treatment of patients exhibiting 3-D jaw bone topography, or when rebuilding lost interproximal bony peaks is required. Between natural teeth, a critical distance of 5 mm or less between the interproximal bone level and the most apical point of the contact area of the teeth is required to maintain a complete fill of the papilla.[21]

Adjacent implants require interproximal bone between the implants above the traditional flat prosthetic table to serve as the support for the interimplant soft-tissue papillae. Until now, this has been particularly difficult to achieve when restoring two or more adjacent implants. When a scalloped implant is placed in a flat, deficient bone site in the ideal biological position and the interproximal scalloped bone apposition surfaces are exposed, interproximal grafting can be attempted.[27]

The soft-tissue biological space around an implant is situated between the crestal bone and the gingival margin. It measures from 3 mm to 4 mm in height and interacts with the enhanced titanium neck design and a ceramic or titanium abutment. Consequently, the abutment-implant interface is disturbed minimally to prevent tissue trauma and the abutment is kept narrow at the mating part with the implant to maintain a stable distance to the underlying osseous structures around the implant. The soft-tissue biologic space allows for the undisturbed approximation of the soft tissues during maturation and ensures that fibers that form are not disrupted during the restorative process.

Implant Placement

Of utmost importance is the primary stability and the optimal position of the implant. The ideal position of an implant takes four different planes into account: apicocoronal, mesiodistal, facial-oral, and implant angulation. The most natural position of an implant is to be an extension of the final esthetic crown. To support this ideal tooth emergence profile and to achieve optimal natural esthetics, it is mandatory to perform a diagnostic wax-up and a subsequent fabrication of a surgical guide prior to implant placement. The design of the template must be such that the desired future gingival margin is visible during the diagnostic, as well as during the surgical phase so that exact measurements can be taken during implant placement.

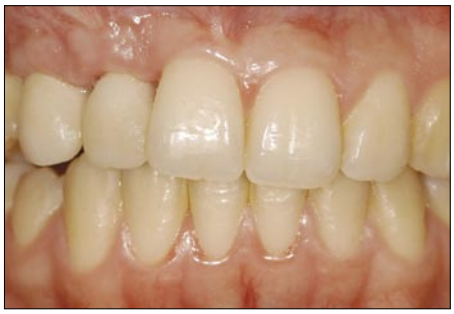

Figure 10. Frontal view of temporary prostheses on two implants after six months of soft-tissue maturation. Note positive tissue level and mucogingival health.

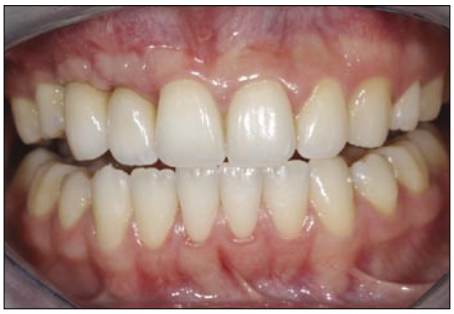

Figure 11. Frontal view of the cementation of two full ceramic restorations on the dental implants. Note harmony of soft tissues and tooth design and ceramic final result.

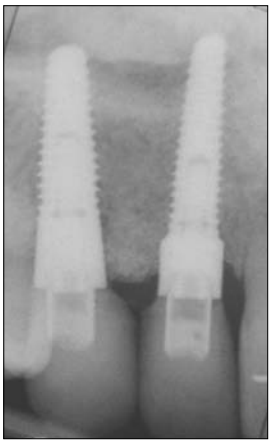

Figure 12. Radiograph of the scalloped implants after one year of functional loading. Note the maintenance of bone level around the neck of the implants resulting in soft-tissue support and an esthetic, pleasing end result. (Prosthetic and ceramic work performed by Peter Wohrle, DMD, Newport Beach, Calif.)

The ideal vertical position of the implant neck is 2 to 3 mm apical to the desired gingival margin on the midfacial. This esthetically oriented vertical implant placement will result in a varying amount of bone coverage depending on the amount of bone present at the implant site and, therefore, may necessitate bone grafting.

In implant sites with adequate existing bone morphology, the bone apposition area of the implant will be placed into the bone while the soft-tissue apposition area protrudes slightly above the bone. In implant sites with existing bone loss, the surgeon has a choice between placing the implant into the residual bone, resulting in a longer crown, or placing the implant in the biologic/prosthetic correct position, grafting the deficient areas either at the time of implant placement, or preferably prior to implant placement. A similar decision needs to be made when existing mesial and distal interproximal bone levels are at varying levels. The surgeon can choose to either augment the deficient site or place the implant in relationship to the lower interproximal bone level, which would result in remodeling of the other more coronal site.

Placement of the implant too far facially or orally will compromise the buccal bone plate and make it difficult to receive a proper thickness of tissue on the facial, and even risk bone resorption and soft-tissue recession. An ideal facial-oral position is 2 to 3 mm lingual to the buccal contour of the final crown with a buccal bone tissue support on the implant of 2 mm.

The mesiodistal implant position takes into account distances between natural teeth and implants (2 mm) and between adjacent implant (3 mm to 4 mm).[22] The angulation of the implant is positioned to follow the occlusal form of the tooth and to allow for a natural emergence profile of the implant crown, but minor angulation problems can be modified in the laboratory phase.

Indications for Use of Enhanced Surface Flat or Scalloped Scalloped Implant and Abutment Designs

A natural esthetic implant outcome is based on long-term stable soft tissue supported by a 3-D osseous foundation. This principle gives a scalloped or enhanced flat top implant and abutment design a potential advantage in the anterior esthetic smile zone and in bone areas with a scalloped profile versus traditional implant design and placement techniques.

The obvious advantage of the biological implant designs is expressed when placing multiple adjacent implants. The design can assist in maintaining or regaining previously lost interproximal osseous structures when a membrane protected bone graft is placed between the exposed bone apposition areas of adjacent implants.

The longest documented scalloped implant case has been in function for more than five years with stable bone and soft-tissue support and a pleasing esthetic result.[27] Most cases with the scalloped implant design have been performed since 2002 and several prospective studies are in progress.[28] The enhanced neck design of a flat top implant with a properly designed abutment material and with minimal trauma done during the prosthetic phase can also stabilize the bone and soft tissues in the esthetic zone.

Soft-Tissue Profile — Biotype

Soft-tissue stability is seen around esthetic implant treatment with less than 1 mm soft-tissue remodeling on the facial and possibly even an increase

of the papilla volume area, when a good amount of surrounding bone and a thick soft-tissue dimension is present.[29] Prior to any soft-tissue grafting, the existing bone substructure must be evaluated to ensure that it is able to support soft-tissue graft placement. Sites that lack hard-tissue support must be reconstructed before initiating this treatment phase. In the maxillary arch, sufficient hard tissue must be present to support the 4 mm of soft tissue that is required to develop optimal esthetic results and maintain the biologic width around implants. To develop a natural emergence profile for the definitive restoration, it is essential to evaluate the quality of soft tissue, and if thin, to increase the amount of keratinized tissue and the volume of the soft tissues. It is similarly important to overcontour the soft tissues and to wait three months for soft-tissue maturation, as soft tissues tend to remodel during subsequent restorative procedures.[30] A general guideline is to overbulk the restorative implant site by at least 1 mm; a guideline for this level is an imaginary line drawn between two healthy gingival papillae of the adjacent teeth to an edentulous space. The possibility of using connective tissue grafting in conjunction with bone grafts or without should be evaluated at every surgical phase, and if necessary performed to prepare for a thick esthetic emergence profile.[5]

Prosthetic Tissue Support and Ceramic Art Design

A variety of prosthetic options ranging from standard cemented to screw-retained crown techniques can be used on a standard or scalloped implant. Essential is the use of sound biological prosthetic principles to guarantee tissue integration and stability at the bone and soft-tissue level. Biocompatible abutment materials like alumina or c.p. titanium allow for a formation of a healthy, mucosal attachment which includes well-dimensioned epithelial and connective tissue portions that are about 2 mm and 1-1.5 mm high, respectively. At sites where abutments made of gold alloy or dental porcelain were used, no proper attachment forms at the abutment level, but the soft-tissue margin recedes and bone remodeling can occur.[16] Atraumatic abutment insertion with early final seating are also key to establish these biological principles. Findings indicate that the multiple dis- and subsequent reconnections of the abutment component of the implant compromises the mucosal barrier and results in a more "apically" positioned zone of connective tissue and bone loss.[15] The one-time shift from a healing abutment to a permanent abutment results in the establishment of a healthy transmucosal attachment, the dimension and quality of which does not differ from those of the mucosal barrier formed to a permanent abutment placed during a second-stage surgery.[31]

Full porcelain-layered ceramic restorations are placed with minimal subgingival placement so that only one margin is in the deeper tissues between the implant-abutment and the second margin between crown and abutment is shallow, within 0.5 mm of the gingival margin following traditional perioprosthetic techniques. This allows for ease of cement rest removal and prevents dental porcelain to be deep within the tissues reacting negatively on tissue stability.[15]

Complications

Surgical complications are reported for a variety of implant placement and bone reconstructive techniques, and therefore need to be considered. Some specific complications have been noted with implant placement in the esthetic zone. These complications are: 1) implant failure, bone graft failure, loss of integration or nonintegration. These are found in the same low percentage as with other osseointegrated implants; 2) bone loss in the bone apposition neck area. In some cases, this leads to soft-tissue shrinkage and a gray shadow from the titanium surface. In other cases, the bone remodeling allows for normal soft-tissue height with no esthetic compromise; 3) loss of gingival papilla support and/or exposure of interproximal implant shoulder. This can be seen in cases with simultaneous bone grafting in which the procedure has failed and has resulted in exposure of the titanium shoulder; and 4) malposition of an implant resulting in a difficult prosthetic and nonesthetic solution or in a need to remove the implant.

Conclusion

The correct implant placement based on biologic surgical and prosthetic principles is essential. This must be achieved by atraumatic soft- and hard-tissue management and prosthetic technique. Esthetic implant therapy demands high precision and delicate tissue handling from both surgical and prosthetic aspects. The argument for using biological designed implant products in patients with a need for a stable esthetic implant crown is convincing. The scalloped or enhanced surface implant and abutment design may be placed in immediate extraction or in healed sites. It may be placed in single units or multiples. It is intended to preserve osseous structures, stabilize soft tissues, and enhance the overall esthetic outcome. CDA

To request a printed copy of this article, please contact / Sascha A. Jovanovic, DDS, MS, Global Institute for Dental Education, P.O. Box 492196, Los Angeles, Calif., 90049; e-mail, info@globalinstituteonline.com.

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IMPLANTS AS ABSOLUTE ANCHORAGE

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ABSTRACT

Anchorage control is essential for successful orthodontic treatment. Each tooth has its own anchorage potential as well as propensity to move when force is applied. When teeth are used as anchorage, the untoward movements of the anchoring units may result in the prolonged treatment time, and unpredictable or less-than-ideal outcome. To maximize tooth-related anchorage, techniques such as differential torque, placing roots into the cortex of the bone, the use of various intraoral devices and/or extraoral appliances have been implemented.

Implants, as they are in direct contact with bone, do not possess a periodontal ligament. As a result, they do not move when orthodontic/orthopedic force is applied, and therefore can be used as "absolute anchorage." This article describes different types of implants that have been used as orthodontic anchorage. Their clinical applications and limitations are also discussed.

One of the most important determinants in successful orthodontic treatment is optimal anchorage control. Nevertheless, due to Newton's third law, teeth that are used as anchoring units also have the same propensity to mobilize as the teeth intended to be moved (moving unit) during orthodontic force application. As movements of the anchoring units are inevitable, orthodontic anchorage is traditionally categorized into maximum, moderate and minimum anchorage, depending on the amount of anticipated movement of the anchoring unit during orthodontic/orthopedic force application.[1] Of the three types of anchorage, maximum

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anchorage is usually most desirable and, at the same time, the most difficult one to achieve. Extraoral devices have been implemented to enhance the stability of the anchoring unit. Nonetheless, they are esthetically objectionable, cumbersome and, most important of all, require a patient's compliance.

Absolute anchorage is the term used to describe the anchoring unit that remains stationary under orthodontic forces. The dental elements that may provide such anchorage are generally limited to ankylosed teeth.[2] However, they are, more often than not, in undesirable positions and should be moved. Therefore, their use as orthodontic anchorage is very limited. Nevertheless, with the advent of the osseointegrated implants, the possibility of functional absolute anchorage is realized.

Implants and Osseointegration

Osseointegration is defined as the direct connection between living bone and load-carrying implant at light microscopic level.[3] Classical requirements to achieve osseointegration include aseptic and atraumatic surgery, primary implant stability, complete tissue coverage and nonloaded healing period of three to six months.[3] Besides, the implant should be made of a bioinert (e.g. titanium, carbon) or bioactive (e.g. hydroxyapatite) and not biotolerant (e.g. stainless-steel, chrome-cobalt alloy) material. The clinical applications of implant-supported prostheses have been well documented and generally high success rates have been reported.[4]

Immediate Loading and Endosseous Implants

While the osseointegration technique had been strictly followed throughout the 1970s and most of the 1980s, toward the end of the 1980s, some of the classical guidelines had been challenged, especially the nonloaded healing period. In 1986, Babbush et al. reported a technique of immediately loaded implant bar overdenture and achieved a cumulative implant success rate of 88 percent up to eight years of function.[5] Since then, numerous studies regarding immediately loaded implants have been published and the rationale established.

The key to the success of immediately loaded implants is achieving primary implant stability and maintaining it until osseointegration is complete. Therefore, the rate and magnitude of osseointegration achieved are also of consequence. Primary implant stability and the rate and magnitude of osseointegration are influenced by the following factors:[6]

Bone Quality

Lekholm and Zarb classified bone quality into four types: Type I, II, III and IV, where Type I is the densest (consisting mainly of cortical bone) and Type IV is the least dense bone (loosely packed trabecular bone with thin cortical bone).[7] Studies have shown that significantly higher implant failure rates were observed when implants were placed in Type IV bone as compared with those placed in Type I – III bone.[4] This is mainly due to the fact that implant-bone interface is much less in Type IV bone, which leads to poor primary implant stability.

Bone Quantity

The quantity of available bone determines the dimension of the implant to be placed. The increase in diameter and/or length of the implant results in the increase in the potential implant-bone contact area (magnitude of osseointegration).[8]

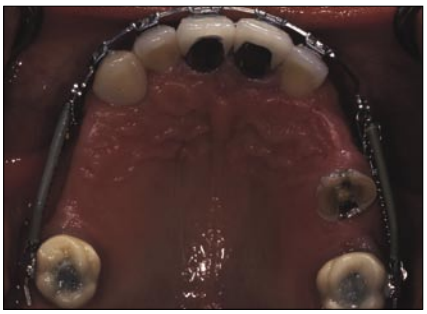

Figure 1. Osseointegrated implants (Nos. 3 and 14) are used as absolute anchorage in a partially edentulous patient who otherwise would not be able to benefit from orthodontic treatment due to inadequate anchorage.

Implant Surface

The surface of endosseous implants may be smooth (machined-surface) or rough (treated-surface). It has been shown that a significantly higher rate and magnitude of osseointegration were achieved with implants that had surface treatment when compared to machined-surface implants.[9]

Implant Geometry

Screw-shaped implants have been shown to provide the strongest immediate mechanical retention after placement.[10]

Prosthetic and Orthodontic Forces

There are substantial differences in both direction and magnitude of prosthetic and orthodontic forces. While prosthetic forces are multidirection, interrupted heavy forces (estimated in kilograms), orthodontic forces generally are unidirectional, continuous and much lighter (from 20 to a few hundred grams).[11] Since endosseous implants have been successfully immediately loaded with prosthetic forces, it is logical to believe that it would be able to withstand orthodontic forces immediately or very soon after placement, without hav-

ing to wait for complete healing of the bone. Roberts et al. demonstrated in an animal (dog) study that implants with less than 10 percent direct bone-implant contact could resist a continuous load of 3 N (~300g) for 13 weeks while maintaining clinical rigidity.[12]

Endosseous Implant as Orthodontic Anchorage

The use of endosseous implants as orthodontic anchorage has been extensively studied as they are viewed as an excellent alternative to traditional orthodontic anchorage methodologies (**Figure 1**). Animal and human studies utilizing osseointegrated implants as orthodontic anchorage to perform different types of orthodontic tooth movements (tipping, torquing, rotation, intrusion, extrusion, uprighting, and bodily movements) under different levels of force (orthodontic vs. orthopedic) have been reported.[11-14] Various anatomic sites have been used for implant location (retromolar, media/paramedian palatal regions, edentulous sites) and a wide range of healing time (four to 36 weeks) has been observed. In all studies, desired orthodontic movements were achieved and osseointegration maintained until the end of the treatment.

Endosseous implants are suitable as orthodontic anchorage due to the following features:

■ Direct bone-implant contact: There is no PDL between bone and implant, therefore the implant does not respond to the orthodontic force (no apposition and resorption).[13] Its immobility makes it an ideal absolute anchoring unit, as lack of reciprocal movement during orthodontic treatment would likely reduce the total treatment time.

■ Though similar in their unresponsiveness toward orthodontic force, unlike an ankylosed tooth, an implant can be placed in a position that will provide optimal mechanical anchorage and not be in the way of tooth movement.[11] This is made possible by the availability of implants of variable sizes.

■ The possibility of immediate or early loading of implant for orthodontic tooth movement minimizes the waiting bone-healing period and thus does not significantly increase the total treatment time.

■ Intraoral location of implants make it appealing to patients who otherwise would need anchorage from esthetically challenged extraoral devices. Furthermore, patient compliance is not required with implant-borne anchoring unit.

Endosseous Implants — A Perfect Absolute Anchorage?

Nevertheless, the use of endosseous implants as orthodontic anchorage has still been limited due to the following reasons:

■ It involves additional surgical procedures and entails significant additional cost. While it has been shown that implant success rates are comparable when they are performed in a sterile or clean condition, aseptic surgery is still recommended for the osseointegration technique.[15] Due to its technique-sensitive nature that requires special setup, implant surgery should be referred to and performed by a specialist.

■ When the implant is placed in the edentulous site, it is likely to be used for the final prosthesis and does not need to be removed. However, when the implant is placed in a nonrestorative location (e.g. mid-palate, retromolar region), it must be removed at the end of the treatment. Since the implant has been osseointegrated, the implant removal usually entails removal of surrounding bone (with trephine burs or high-speed carbide bur) and thus can be more traumatic than the implant insertion. Multiple surgeries can also be objectionable to some patients.

■ In partially edentulous patients, the implant(s) may be placed in the planned edentulous site(s) to be used for the final prosthesis as well as not to interfere with the programmed orthodontic movement. However, this requires an interdisciplinary approach that demands a very accurate prosthetic setup, precise implant placement, and errorless orthodontic execution. Any minute mistake may result in an esthetically compromised situation that warrants implant removal during the course or at the end of the treatment.

■ Since osseointegrated implants are in a state of ankylosis, they do not follow the development of the adjacent structures.[16] Implants placed in the edentulous sites of a growing patient will result in vertical tissue discrepancies that are virtually incorrigible at the end of growth. Therefore, their use in partially edentulous situations is essentially limited to nongrowing patients.

Alternatives to Endosseous Implants

To cope with the limitations of endosseous implants as orthodontic anchorage, several alternatives, collectively termed temporary anchorage devices, have been advocated. These devices can be placed transosteally, subperiosteally, or endosteally and can be fixed to bone either biochemically (osseointegrated) or mechanically (cortically stabilized).[17] They can be used as indirect absolute anchorage when connected to the anchoring teeth or direct absolute anchorage when connected to the moving unit, and as the name implies, these devices are to be removed after use.

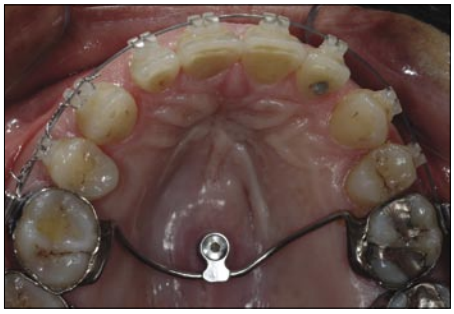

Figure 2. An onplant (Nobel Biocare, Yorba Linda, Calif.) is used to assist anchorage provided by the transpalatal bar.

Figure 3. Skeletal anchorage system consists of titanium miniplate and monocortical screws (Leibinger Micro Implants, Portage, Mich.).

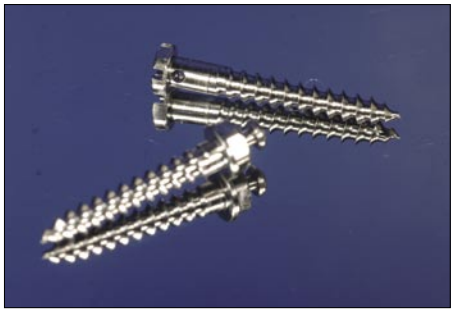

Figure 4. Dual-top anchor orthodontic miniscrews (RMO, Denver, Colo.) are designed for orthodontic procedures.

Figure 5. Osteotomy fixation screws (ACE Surgical Supply, Inc., Brockton, Mass.) are made of titanium alloy and therefore can also be used as absolute anchorage.

Onplant

Onplant (Nobel Biocare, Yorba Linda, Calif.) is a thin titanium alloy (6Al4V) disk, textured and coated with hydroxyapatite on one surface and a threaded hole on the opposite side. It is to be inserted subperiosteally with the HA-coated side against bone for osseointegration. Since onplant is placed "on" the bone surface and not into the bone, it can be used in growing patients without affecting the skeletal development. The abutment is designed to receive up to 0.051-inch wire and thus does not significantly alter the routine orthodontic practice. Block and Hoffman had demonstrated in their animal studies that after 10 weeks of healing in dogs and 12 weeks in monkeys, the onplants were able to withstand 11 ounces (~300 g) of force for five months in dogs, and 250 g of force for six months in monkeys.[18] They found that orthodontic movement of the teeth was achieved without any movement of the onplants. Histologic examination also showed a direct contact between bone and the HA-coated surface of the onplants. They concluded that onplants could provide absolute anchorage for orthodontic tooth movement.

Onplants are usually placed in the mid-palatal region with the transpalatal bar incorporated to the abutment (**Figure 2**). Gunduz et al. reported a high patient acceptance rate of palatal implants.[19] Most patients got used to their implants in about two weeks and 75 percent of the patients found the orthodontic construction between the anchor teeth and the implant less comfortable than the implant itself. Furthermore, the removal of onplant does not involve bone removal and therefore not as traumatic as osseointegrated implant removal.

Since onplant is placed on the bone, there is minimal initial direct contact between bone and onplant and the initial stability of the onplant is of soft tissue origin (subperioteal tunnels) and not hard tissue origin. Therefore, for nonplants to be used as orthodontic anchorage, a complete surface integration between the bone and HA-coated surface must be achieved, an additional healing period of five to six months is required. An animal (rabbit) study using recombinant human bone morphogenetic protein-2 (rhBMP-2) and dentin matrix protein-1 (DMP-1) in conjunction with onplants has been carried out in an attempt to reduce the waiting period before orthodontic force application.[20] After six weeks of healing, histological and histomorphometric results demonstrated significant more bone formation at the bone-onplant interface in the rhBMP-2 group when compared to DMP-1 group and control (onplant only). Mechanically, rhBMP-2 group also withstood significantly higher tensile force (3.4-5 kg) than DMP-1 group and control (0-1.3 kg). However, Roberts postulated the rate of bone remodeling in rabbits is ~three times faster than humans.[21] Six weeks of healing in rabbits might be equivalent to 18 weeks in humans and clinical application of this result is, therefore, questionable. Furthermore, publications regarding onplant application are scarce and limited to case reports and animal studies.[18,20,21] Well-controlled human studies are needed before its clinical application can be in the mainstream.

Skeletal Anchorage System

The skeletal anchorage system consists of titanium miniplates and monocortical screws (**Figure 3**) that are temporarily placed in either the maxilla or the mandible, or both, as absolute anchorage units. Since the anchor plates work as the onplant and screws function as the implant, SAS enables the rigid anchorage that results from the osseointegration effects in both the anchor plates and screws.[22] Furthermore, because all portions of the anchor plates and screws are placed outside the maxillary and mandibular dentition, the SAS does not interfere with the tooth movement.[22] The miniplates are available in various shapes and sizes, and are easily adaptable to most bony surfaces (e.g. buccal plate, zygomatic process, retromolar etc.). They also can be used for a variety of anchorage purposes (molar intrusion, molar distalization etc.). The surgery is simple, minimally invasive, and appropriate to an office setting.[23] While orthodontic force could be applied immediately after placement, it is advisable to wait until the wound is healed.[23] Healing periods of four to seven days up to three months have been reported.[23] The disadvantages of this technique include the necessity of flap reflection, mild infection, and the discomfort associated with the placement, maintenance, and removal of the plates.[24]

Mini-implants, Microscrews, Pinplants

Mini-implants have recently been introduced as simpler absolute anchorage alternatives to endosseous implants and onplants in orthodontics.[17,25-30] This group of implants includes titanium implants that are 2.5 mm or less in diameter.[17] They can be implants made especially for orthodontic procedures

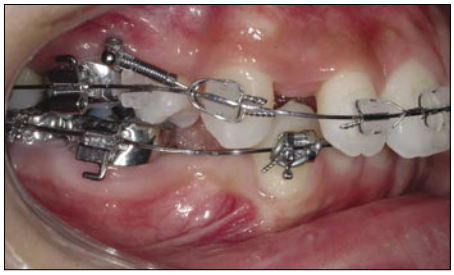

Figure 6. A mini-implant (Ortho Implant, Imtec Corp., Ardmore, Okla.) is used as direct absolute anchorage when it is connected to the moving unit (No. 6).

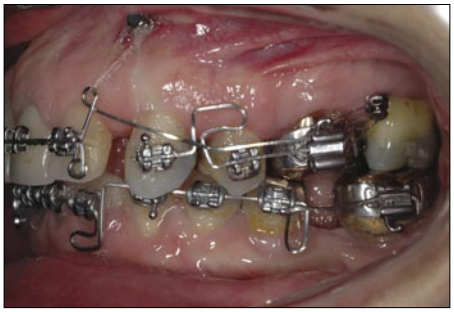

Figure 7. When a mini-implant (AnchorPlus, Myung Sung, Seoul, Korea) is connected to the anchoring unit (No. 14), it is considered as indirect absolute anchorage.

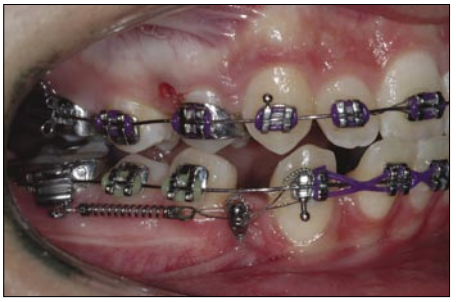

Figure 8. A mini-implant (Ortho Implant, Imtec Corp.) can be used as direct and indirect absolute anchorages at the same time when it is connected to both the moving unit (No. 30) and anchoring unit (No. 27).

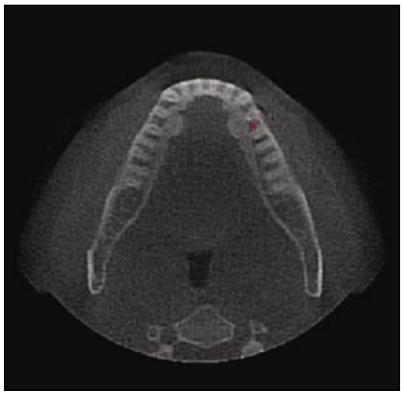

Figure 9a.

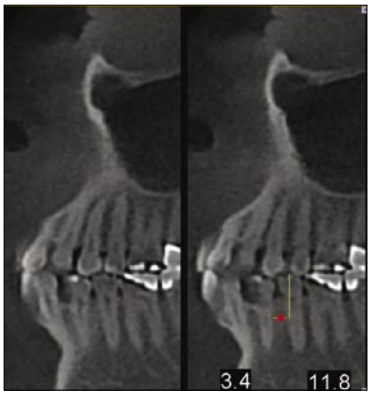

Figure 9b.

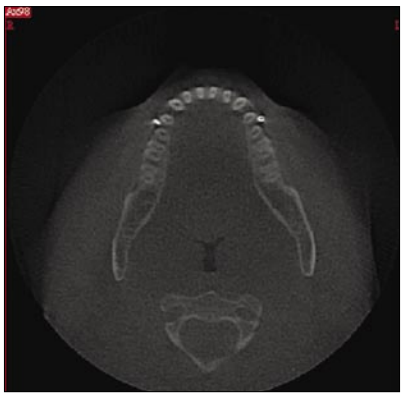

Figure 9c.

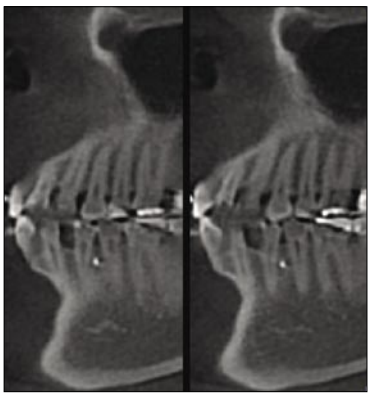

Figure 9d.

Figure 9. Cone-beam computed tomography (Newtom 3G, Aperio Services LLC, Sarasota, Fla.) provides 3-D views essential in treatment planning the mini-implant position. **a)** Preoperative axial view; **b)** preoperative sagittal view. Red dots signify predetermined mini-implant position. Accurate mini-implant placement was achieved as shown in **c)**. Postoperative axial view, and **d)** postoperative sagittal view.

(**Figure 4**) or simple osteotomy fixation screws (**Figure 5**). The main advantage of mini-implants is their small size (as small as 1.0 in diameter and as short as 4 mm) and the size variety.[25] This significantly increases the potential sites for implant placement especially the interradicular/pararadicular regions. The surgical placement of a mini-implant is also much simpler than endosseous implants, onplants and miniplates, and can be easily performed in orthodontic settings by orthodontists. The additional cost involved is therefore much less than other absolute anchorage systems.

The orthodontic load is usually applied to the mini-implant immediately or very early after placement.[26] A waiting period is not necessary because its primary stability is generally sufficient to sustain normal orthodontic loading. Even though it has been shown histologically that premature loading would result in the fibrous tissue interposition at the bone-implant contact, this did not compromise the clinical stability of the mini-implants. Furthermore, it has been suggested that this phenomenon is favorable because it would facilitate implant removal at the end of the treatment.[26] The implant removal entails

unscrewing the implant with minimal use of an anesthetic agent.

A mini-implant can be used as direct and/or indirect absolute anchorage at the same time or at different point of time (**Figures 6-8**). To use the mini-implant efficiently, a thorough understanding of orthodontic mechanics associated to mini-implants is essential. To be used as direct absolute anchorage, the line of action of the force has to pass through the mini-implant.[27] When the line of action of the force does not pass through the mini-implant, a moment of force is generated resulting in shearing force.

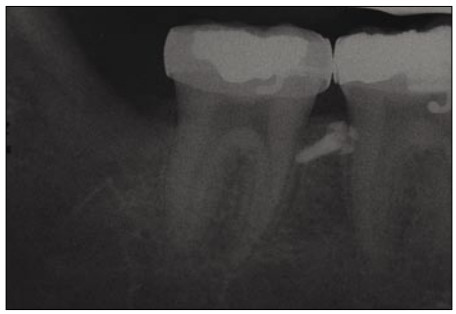

Figure 10. When the PDL is violated, the patient usually develops pain on percussion or mastication.

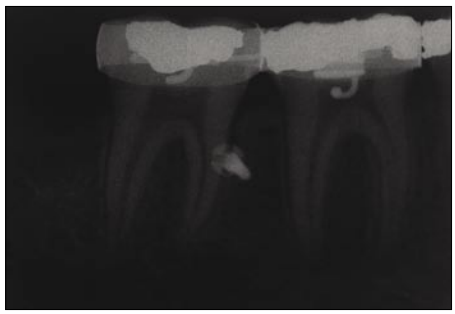

Figure 11. The mini-implant that invades vital structure should be removed as soon as possible and a new mini-implant can be placed immediately.

Since the mini-implant is only mechanically fixed to bone via cortical stabilization and is not osseointegrated, the shearing force may be detrimental to the mini-implant leading to its failure. In such a situation, the mini-implant should be tied to the anchoring unit and used as indirect absolute anchorage.[27] The treatment plan should be established to maximize the use of the mini-implant and avoid its untimely removal and/or replacement.

Since mini-implants are small, the planned implant sites can sometimes be very close to vital structures e.g. neurovascular bundles, sinuses and root of tooth etc. Care must be taken not to violate those structures and axial tomography (**Figures 9a-d**) is recommended during implant site planning. Mini-implants that invade periodontal ligament usually results in pain on percussion or mastication, whereas when the root is violated, the patient will develop sensitivity to hot and cold.[28] The mini-implant should be removed as soon as the symptoms develop (**Figures 10-11**). Once removed, the symptoms generally subside and pulpal damage is unlikely.[27-29] In addition, Fabbroni et al. showed that the incidence of clinically significant damage of teeth that had been impinged by transalveolar screws was very low.[30]

Small diameter, while providing versatility in implant location, increases the risk of implant fracture during implant removal if the achieved osseointegration level exceeds the implant mechanical strength. Since osseointegration is not required for orthodontic anchorage, the mini-implant surface should be machined (smooth) and not treated (rough). While data regarding optimal implant diameter is lacking, a minimum of 1.5 mm diameter has been recommended.[17,25-30]

Conclusions

Incorporating implants to orthodontic treatment is an exciting venue and is inevitable. However, to achieve successful outcomes, a thorough understanding of each type of implant, its indications and limitations is essential in the decision making. When an interdisciplinary approach is warranted, comprehensive diagnosis and treatment planning must be established through effective communication followed by meticulous execution. CDA

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Distraction Osteogensis: A Surgical Option for Restoring Missing Tissue in the Anterior Esthetic Zone

Alan S. Herford, DDS, MD

Abstract

Common causes of alveolar defects include bone resorption due to loss of teeth, infection, or trauma. There is often insufficient height or width of residual bone, and ridge augmentation may be required prior to implant placement. These defects range from small alveolar deficiencies to more complex, extensive bony defects.

Various techniques are available for reconstructing alveolar ridges. Without augmentation, dental implants may have to be placed in anatomically unfavorable positions or have adverse angulations. These position/angulation compromises can lead to esthetic dissatisfaction, mechanical overload, and possibly implant loss. Both bone grafting and distraction osteogenesis are predictable methods for restoring missing tissue.[1-17]

Distraction osteogenesis is the technique of forming new tissues by gradually expanding existing tissues (bone and overlying soft tissue). By utilizing the body's own capacity to heal itself, new tissues can be created. Applying tension forces across an osteotomy site induces bone growth. Distraction osteogenesis can be used to reconstruct a variety of alveolar defects. An advantage of this technique is that both hard and soft tissues are recreated, "distraction histiogenesis." This differs from traditional methods of reconstruction such as bone grafts, which only replace the missing bone.

The anterior esthetic zone is often the most difficult area in the mouth to obtain cosmetically acceptable results.[18-24] This is especially true in patients exhibiting a high smile line. Distraction

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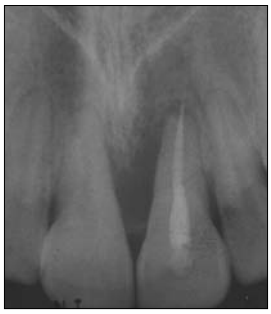

Figure 1a. Traumatic injury to central incisors with root fracture of tooth No. 9.

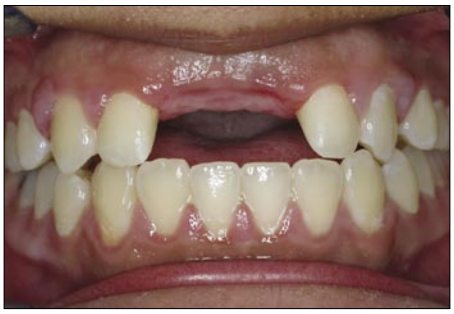

Figure 1b. Alveolar defect with missing tissue.

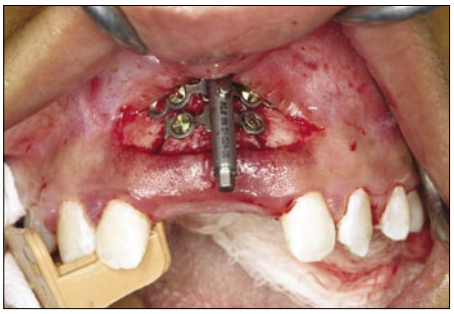

Figure 1c. Distraction device in place. Note the incision in keratinized tissue.

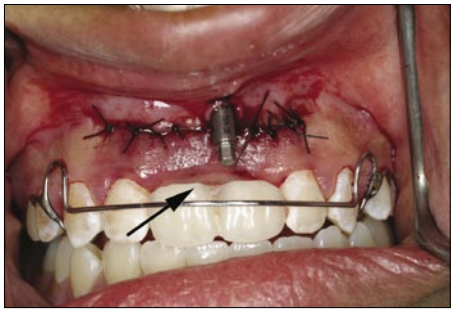

Figure 1d. Removable prosthesis in place. The crowns on the prosthesis were shortened (arrow) to provide room for the transported bone.

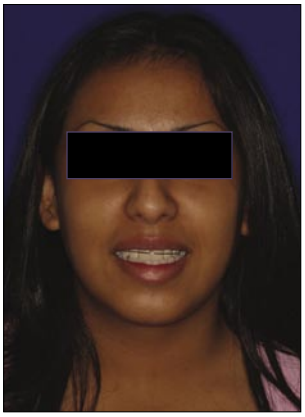

Figure 1e. Postoperative result.

osteogenesis is an option for restoring tissue in this area.

Treatment Planning

Patient evaluation proceeds in a stepwise manner. An algorithmic approach is helpful during the treatment planning process and aids in determining the ideal method for restoring missing tissue.[1] The clinical exam focuses on evaluating the characteristics, including size and geometry of the defect. It is important to note any hard and/or soft tissue deficiencies on exam and by examining the dental models. This data is compiled and a treatment plan is devised based on the characteristics of the defect.

Surgical Procedure

After careful preoperative planning, an osteotomy is created in an area requiring bone augmentation. The bone cut is created at the base of the alveolus where there is sufficient thickness of bone. A distraction device is then secured into place and the incision is closed. Alveolar devices are currently either endosseous or extraosseous. Both devices require removal prior to implant placement.

Typically, a period of no bone movement (seven-day latency period) is observed prior to activating the device. During the next phase, activation phase, the patient turns the distractor daily, which causes the bone segments to separate, approximately 1 mm per day. After the bone is distracted the desired amount, the patient stops activating the device. During this time, it is important to maintain the correct vector. It is left in place to stabilize the distracted bone for a period of typically two to three months (consolidation phase). After the regenerate has ossified, the distractor device is removed and osseointegrated implants are placed.

Case 1

An 18-year-old patient sustained a fall with trauma to her maxillary central incisors (**Figure 1**). She developed progressive bone loss and presented for treatment. On examination, she was noted to have adequate soft tissue but insufficient bone tissue for implant support. She underwent distraction osteogenesis prior to implant placement. The active phase of distraction lasted 10 days. The distraction device was removed three months later.

Case 2

A 28-year-old patient underwent repair of her alveolar cleft deformity with an iliac crest bone graft at age 8 (**Figure 2**). She underwent distraction

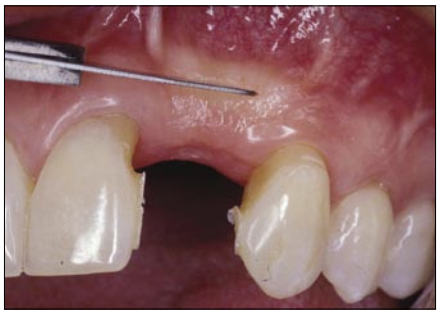

Figure 2a. Incision is placed in attached mucosa.

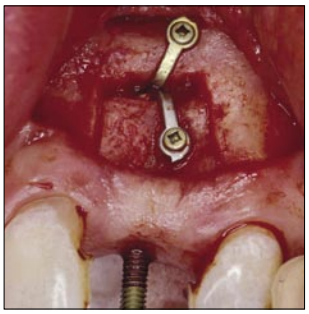

Figure 2b. Intraosseous distraction device in place. Note the activation rod exits at the anticipated site of the future dental implant.

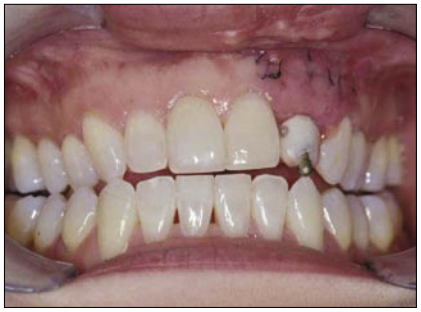

Figure 2c. Removable prosthesis provides vector control during the activation phase.

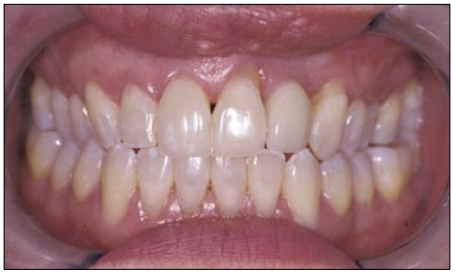

Figure 2d. Postoperative result.

osteogenesis with an intraosseous distraction device prior to implant placement to provide additional bone for a more esthetic result. The initial incision was made in keratinized tissue in order to regenerate more keratinized tissue. The distraction device was activated for eight days. This was followed by 10 weeks of consolidation.

Case 3

A 51-year-old patient had had trauma from a motor vehicle collision and undergone multiple failed grafting attempts (**Figure 3**). She was missing both hard and soft tissue, and had extensive scarring from the previous surgeries. The area was reconstructed using distraction osteogenesis followed by dental implant placement. The active phase of distraction lasted 12 days and was followed by three months of consolidation prior to distractor removal.

Case 4

A 73-year-old patient had undergone a maxillary sinus lift followed by implant placement (**Figure 4**). She presented for further reconstruction of her anterior maxilla. On clinical examination, she was noted to have two separate defects in this region. One area, both horizontal and vertical defect, was amenable to distraction osteogenesis whereas the other, knife-edged ridge, was more suited for an onlay bone graft. This case illustrated the importance of identifying the characteristics of a defect including both the size and geometry of the area. The active phase of distraction lasted 12 days. The distraction device was removed three months later.

Discussion

Distraction osteogenesis can be applied to the dentoalveolar area to create new bone and mucosa. Esthetic and functional compromise can be prevented by ridge augmentation procedures and enhanced emergence profiles of the implants can be obtained. Because of the abundant blood supply, a large amount of bone can be generated in the facial region. This allows the clinician to overgrow bone and then remove the excess, e.g. knife-edge ridge, to develop an ideal bony bed into which implants can be placed.

There are many advantages of distraction osteogenesis over other methods for reconstructing missing tissue. It is less invasive, less time intensive and associated with less morbidity than harvesting bone grafts. It often eliminates the need for a bone graft and can expand the soft tissue matrix. Another significant advantage is that both hard and soft tissues are reconstructed with this technique. An important disadvantage is that the technique takes time and the patients must be monitored closely during the activation period. Careful patient selection is important for success of this procedure.

Distraction osteogenesis is ideally suited for reconstructing defects in the anterior esthetic zone and has advantages over bone grafting especially in this region.[1,19,20] To achieve tension-free closure over a bone graft, extensive undermining of the labial mucosa and the lip mucosa is often required. This results in loss of vestibular height and

Continued on Page 894

Table 1

Analysis of studies regarding implants placed in distracted bone.

Authors (Yr)	Procedure (# of Pts.)	Type of Alveolar Distraction Device	Latency	Rate & Rhythm	Distraction (Mean)	Consolidation
Chiapasco et al [16] (2001)	Maxilla (1) Mandible (7)	Extrabony	7 days	0.5 mm 2x per day	6-15 mm (8.75 mm)	2-3 mos.
Jensen et al [17] (2002)	28 pts, 30 sites Maxilla (28) Mandible (2)	Intrabony (screw device) (implant device)	7 days	1mm 3x per wk.	3-15 mm (6.5 mm)	2 mos.
Feichtinger et al[11] (2003)	(35)	Intrabony (dental implant distraction)	7-10 days	0.25-0.5 mm per day	4-6 mm	4-6 mos.
Rachmiel et al[12] (2001)	14 pts Maxilla (6) Mandible (8)	Intrabony	4 days	0.4 mm 2x per day	8-13 mm (10.3)	2 mos.
Uckan et al[5] (2002)	10 pts Ant. Mand (7) Ant. Max (2) Mandible (1)	Intrabony	7 days	0.4 mm 2x per day	5-15 mm (8.7 mm)	3 mos.
Garcia et al[14] (2002)	Post Mand (6) Ant. Mand (1)	Intrabony	7 days	0.5 mm 2x per day	Not reported	12 wks.
Raghoebar et al [3] (2002)	Ant. Mand (10)	Extrabony	5 days	0.5 mm 2x per day	6-8 (6.8)	2 mos.
Urbani [15] (2001)	(5)	Intrabony (implant distraction)	5-7 days	0.8 mm per day	4-7 mm (5.2)	73-165 days (87)
Zaffe et al [4] (2002)	Mandible (10)	Extrabony	5 days	0.5 mm 2x per day 0.25 mm 4x per day	10-15 mm (12)	8 wks.
Uckan[6] (2002)	Mandible (3)	Intrabony	7 days	0.4 mm 2x per day	11-13 mm (12)	12 wks.
Millesci-Schobel[16] (2002)	Mandible (4)	Extrabony	7 days	0.3 mm 3x per day	6-9 mm	10 wks.
Chiapasco et al[13] (2004)	(37)	Extrabony	7 days	0.5 mm 2x per day	4-15 mm (9.9)	2-3 mos.

# of Implants Placed (Mean)	# of Implants Lost	F/U (Mean)	Implants Placed? (Time after Distraction)	Complications
26 implants (3.25)	0/26	12 to 18 mos. (14 mos.)	Yes (2 to 3 wks.)	None reported.
84 implants (2.8)	8/84	3-4.4 yrs.	Yes (2 mos.)	8 implants failed to integrate; 19/30 required bone graft; 4/30 require soft tissue grafting; 7/30 had device failure; 14/30 segment relapse.
62 (1.8)	2/62	9 mos.	Yes (4-6 mos.)	2 distraction implants failed to osseointegrate; 2 pts with premature bony union; 1 pt had over-correction; 3 implants with > 3 mm probing depths.
23 (1.6)	1/23	0.25-0.5 mm per day	Yes (60 days)	Loss of 1 implant due to instability of distracted bone segment; One fracture of distractor; 1 pt with temporary hypoesthesia of mental nerve.
20 (2)	3/20	10-36 mos. (1-8 yrs.)	Yes	5 pts (50%) with displacement of the distraction segment; 3-lingual displaced; 1-palatal; 1-fracture of distracted segment; 1-intraoperative study.
14 (2)	0/14	Not reported	Yes	7/7 (100%) rate of complications; excessive length of distraction rod (1); Fx of transport segment (1); difficulties in completing lingual osteotomy (7); incorrect vector (2); perforation of the mucosa by transport segment (2); bone defect (4); less than ideal restoration (3/7).
20 (2)	1/20	6-20 mos. (11.2 yrs.)	Yes	2 pts with relapse caused from backward rotation; dehiscence (1); Implant lost (1).
11 (2.2)		Not reported	Yes (46 days)	Lingual displacement of the bone segment (1).
Not reported	Not discussed	Not reported	Not reported	Loss of depth of vestibule (3/5 edentulous pts); 1/10 incorrect vector.
8 (2.7)	1/8	19-36 mos. (27.5)	Not reported	One implant lost.
Not reported	Not reported			One fracture of distractor (1/4).
138	0/138	15-55 mos. (34 mos.)	2-3 mos.	Mandible fracture; lingual inclination; incomplete distraction; palatal inclination

Continued from Page 891

apical repositioning of the keratinized tissue in order to cover the graft during graft consolidation. A secondary procedure such as soft tissue grafting and/or vestibuloplasty may be required to achieve acceptable results. The technique of distraction osteogenesis avoids this extensive undermining and avoids altering the normal tissue architecture of the labial mucosa. It also generates new mucosa, thus avoiding the need for later soft tissue grafting.

Several studies have evaluated implant success in distracted bone (**Table 1**).[3-6,10-17] Collectively, in these studies, 406 implants were placed and 16 were lost for an overall implant loss rate of 4 percent. No long-term studies have evaluated the effect of implants in maintaining the distracted bone height. Implants are effective in decreasing the amount of resorption when placed in grafted bone.[26] This is true of both loaded and nonloaded dental implants. Distracted bone likely responds in the same way.

The timing of removal of a distraction device typically is between two to six months after the completion of distraction osteogenesis. Earlier removal of a device may result in inadequate ossification during the consolidation phase with significant relapse. Often, the implants are placed during the same surgical procedure. The authors consider removal of the distraction device at two to three months and placement of implants if sufficient basal bone, nondistracted, is present to provide for primary stability of the implants. If the majority of stabilization for the implant is provided by newly formed bone, then the authors will wait six months prior to implant placement.

It is preferable to make the initial incision in keratinized tissue if possible (see Case 2). This is especially true in the anterior esthetic zone. This leads to regeneration of keratinized tissue rather than movable mucosa.

It is important to maintain the desired vector during the distraction process. This will ultimately lead to the desired location of the transported bone and therefore the ideal location for placement of the implant. There are many techniques for maintaining the correct vector.[18]

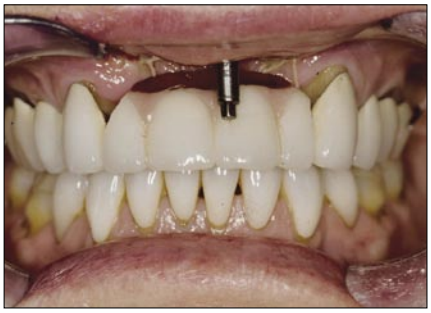

Figure 3a. Anterior defect with extensive tissue loss and scarring. The prosthesis aids in counteracting the strong palatal pull during distraction osteogenesis.

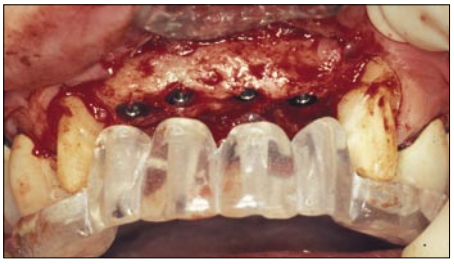

Figure 3b. Implants are placed in the regenerated bone.

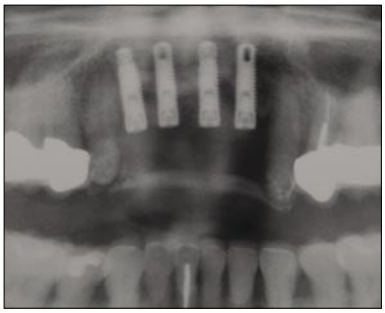

Figure 3c. Radiograph of dental implants.

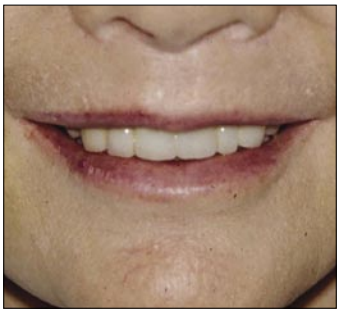

Figure 3d. Postoperative result.

Conclusion

Alveolar distraction osteogenesis is a predictable method for restoring alveolar ridges prior to implant placement. Distraction osteogenesis is ideally suited for recreating missing tissue in the anterior esthetic zone. CDA

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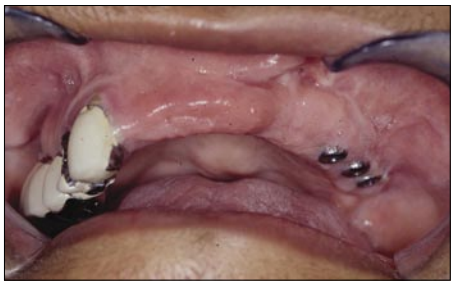

Figure 4a. Maxillary defect. Note the adequate soft tissue.

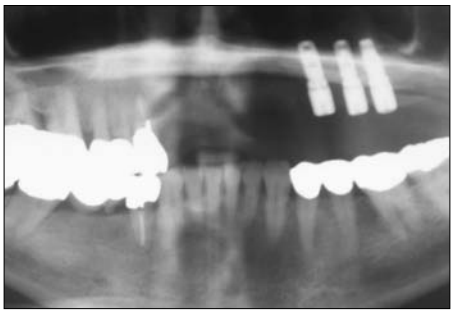

Figure 4b. Radiograph showing the inadequate bone for implant support.

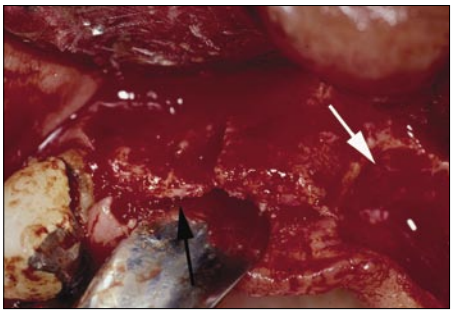

Figure 4c. Two separate types of defects adjacent to each other. Knife-edge (black arrow) defect and horizontal and vertical defect (white arrow).

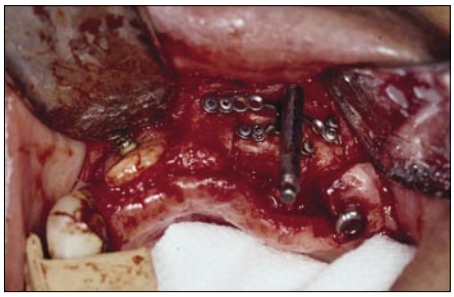

Figure 4d. Block graft secured in place and distraction device placed.

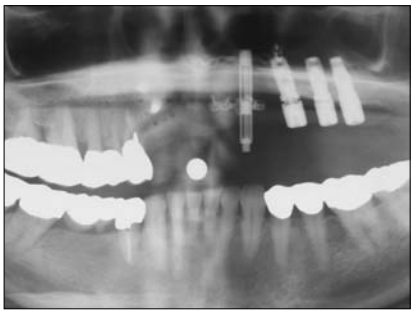

Figure 4e. Radiograph showing the regenerated bone.

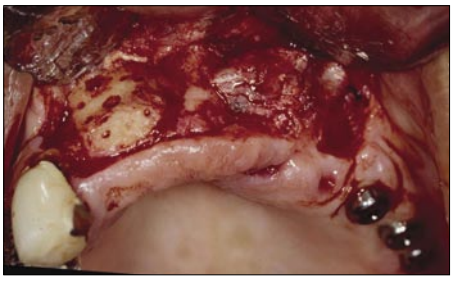

Figure 4f. Regenerated bone prior to implant placement.

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Robert E. Horseman, DDS

Accuracy in the OR Is Nothing to Sneeze At

A dentist, like a juggler, is an individual whose right hand should always know what his left hand is doing. That's why dentists take exceptionally good care of their hands. Male dentists, of course, have to learn this the hard way because in their younger days, they attempted to play baseball or handball with other clueless males.

Exercising every precaution and opting for an early retirement, most of us find our hands professionally functional as long as we need them.

The learning curve is steep, but with enough finger injuries, even the most unreconstructed eventually concede there are some things they should eschew.

In spite of the fact the first and best do-it-yourself kit consists of your own pair of hands, most dentists learn to keep their fingers away from power saws. If they ever have to pound a nail, it becomes prudent to hold the hammer with both hands. Exercising every precaution and opting for an early retirement, most of us find our hands professionally functional as long as we need them.

There are exceptions. My little finger on my right hand — a finger that has lain dormant for the last eight decades except to extend itself in a proper fashion at tea parties — has suddenly become painful to flex. As usual with ailments that occur almost every day in the Golden Years, I ignored the discomfort until I found myself seeking compassion from an orthopedic surgeon.

"You've got a 'trigger finger'," he opined cheerfully. Having heard all the protests from innocents who have never triggered a gun in their lives, he went on to explain in one-syllable words for my benefit the problems of the flexor muscle as it passes through a series of sheaths. These have somehow become clogged with the detritus of a misspent life and it now impedes the smooth passage of the muscle inside them. I wept softly into a small pillowcase I brought along for that purpose.

I wanted to ask why this particular maverick finger has gone rogue and not one or more of the other nine. But he remained busy explaining that he would perform a "trigger release" operation, whereupon he vanished. His nurse, who had been lurking in the shadows leafing through a Victoria's Secret catalogue, emerged to hand me a ream of papers to be signed and an appointment card for the surgery. She wanted a complete blood workup and an EKG. It's best not to argue, I'm thinking, grateful it's

Continued on Page 914

Overkill is not a word I like to associate with a surgery center, but this seemed a little excessive for a piece-of-cake job on my little finger.

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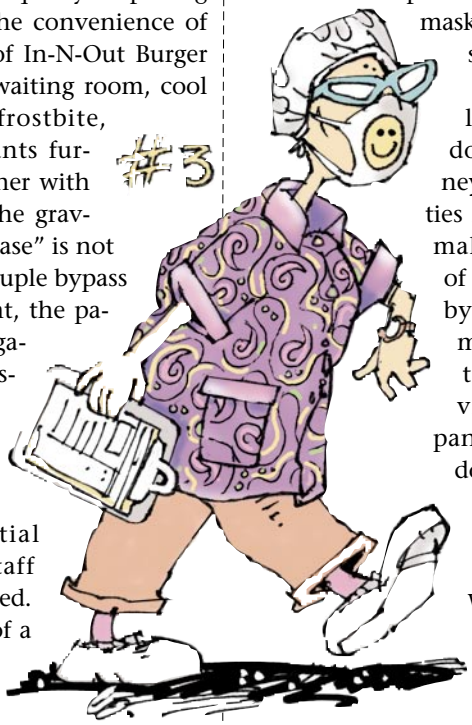
not a major bowel obstruction.

I fronted up at the Same Day Surgery Center, an imposing edifice designed to alleviate the high cost of extended hospitalization. An equally imposing fee was offered for the convenience of speed, rivaling that of In-N-Out Burger outlets. The austere waiting room, cool enough to induce frostbite, was full; the occupants furtively eyed one another with loathing. Although the gravity of my "trigger release" is not on a par with a quadruple bypass or a kidney transplant, the paperwork and interrogations by staff were essentially the same.



"Fill out these forms, both sides, sign here, and here, and here, and initial here, and here," Staff Person No. 1 instructed. She gave me a copy of a waiver absolving the entire staff and their families of any liability. "Just a formality," she smiled with a hint of a wink. "Are you allergic to anything?" Dutifully noting my negative response on her clipboard, she left. Staff Person No. 2 appeared, professional in green scrubs, booties, and a small likeness of Jerry Garcia tattooed on one ankle. "Are you allergic to anything?" she demanded. I am about to mention I had already denied the allergy thing, but state no again. Satisfied, she said, "That'll be $100 co-payment." As she absconded with my money, leaving a visible vapor of Jean Naté in her wake, Staff Person No. 3 materialized, commanding me to follow her. Her ensemble was topped with a paisley blouse and stylishly contrasted blue cotton scrub pants. She wore a face mask with an embossed smiley face.

We entered a large room with a dozen or more gurneys occupied by parties in various states of malaise. A minimum of privacy is provided by movable ceiling-mounted curtains that leave only a view of the occupant's varicosities on down. The place resembles a Toyota assembly line where the unwell are ushered in one end, to be slid out the other, swathed in bandages, and stamped **FINISHED**.

SP No. 3 (played by actress Marjorie Main) entered my cubicle and wheezed, "Are you allergic to anything?" These people are *really* concerned about allergies apparently, but somehow the word has yet to filter down through the entire organization. "OK," she rasped cheerfully, "take off everything and put on this gown. Place your clothes in the plastic bag — socks, shoes, wristwatch, and any prosthetic devices you may have."

"*Everything?*" I try not to appear alarmed. Overkill is not a word I like to associate with a surgery center, but this seemed a little excessive for a piece-of-cake job on my little finger. "I'm just having a correction here on my little finger," I protested, wiggling that digit to verify my status.

"No," she countered, "you're scheduled for arthroscopy on your right knee. Says right here on your chart."

"My knee is fine, it's my little finger!"

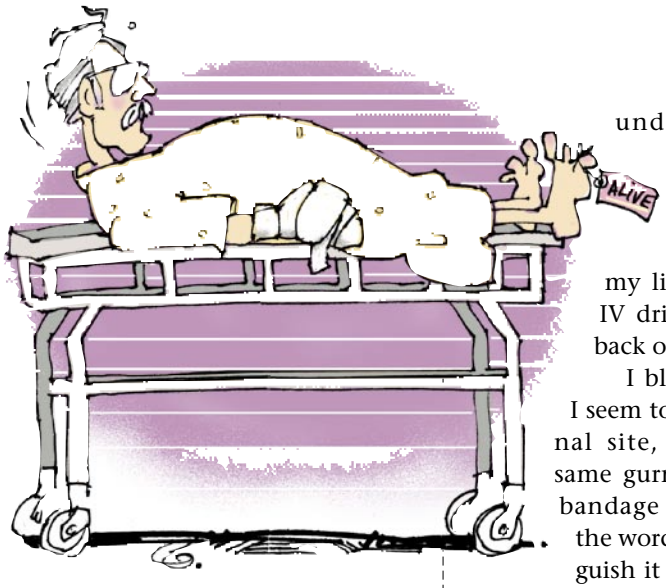
"You sure?"

"Absolutely!" I thought it's more than allergies they should be worried about as she scuttled off to consult with upper management.

SP No. 4 entered the arena, accompanied by SP No. 3 and a gaggle of interested spectators. "Not right knee arthroscopy?" she queried in a tone that suggested I was faking the whole thing.

Several skeptics exposed my right knee and prodded it excessively. I feared I was about to be Miranda-ized. I flexed my finger painfully in her direction. Reluctantly, she plucked a red felt-tip marker from her embonpoint and drew a wavy line the length of the finger, putting a little star at each end. "There!" she declared, resigned. "By the way, are you allergic to anything?"

I disrobed quickly, trying in vain to secure the strings in the back of the gown, slipped on my attractive blue booties and arced awkwardly onto the gurney. I placed my designated finger out in plain sight in case there was trouble ahead. Another female, who may or may not have been SP No. 4, arrived to announce the anesthesiologist was on his way and should be here within a fortnight. She covered me with



a warm blanket, neglecting to ask me about my allergies to wool or polyester.

"Hi, I'm Dr. Wu, your anesthesiologist," he proclaimed, inscrutable behind his face mask. "You allergic to anything? Right knee arthroscopy," he muttered, checking his chart.

Oh, God! "No, no, no!" I bleated, waving my red-marked finger vigorously. He looked at me blankly, huddled briefly with either SP Nos. 1, 2 or 3 for confirmation and trotted off to have the whole OR setup dismantled to conform to the lesser task. Obviously he was disappointed. It was like being all set for a full-crown prep and find it's just a buccal pit.

Finally, I was in the operating room with the big lights and the banks of blinking LED lights in a choice of M&M's colors. A vocal contingent of salaried people in full OR gear milled about, exchanging light-hearted banter. Latex hands slipped in under my blanket and whisked my gown right off of me, reminiscent of the showman who yanks the tablecloth out from under the plates and glasses without disrupting anything. I am now stark-buck naked, including my little finger. I feel the IV drip butterflied on the back of my hand.

I blinked once or twice. I seem to be back in my original site, recumbent on the same gurney. My hand had a bandage on it, lacking only the word EVERLAST to distinguish it from a boxing glove.

I experienced no drowsiness or hangover. My gown was mysteriously back in place, causing me to wonder if I might be another victim of a cruel hoax commonly played on old people.

One of the battalion of staff people hovered bedside. "OK," she smiled, "hop off and I'll help you get dressed."

"That's it, I'm finished?" Disbelief vied with astonishment. She nodded, expertly shoe-horning me into my shorts with no discernable embarrassment except mine.

"Call your doctor for a postop appointment in a week." She hurried off like Lewis Carroll's rabbit. Got to keep the assembly line moving.

So that is the state of medicine today. On my way out, I told the admitting nurse (played by Cloris Leachman), "My knee feels 100 percent better. It's a miracle!"

"Sign this release form," she said without expression, "and indicate with a check mark whether you are allergic to anything." Her eyes darted between my hand and the chart. Would you tell her? Neither would I, but I *would* like the name of that anesthesia in case it ever becomes OTC. CDA