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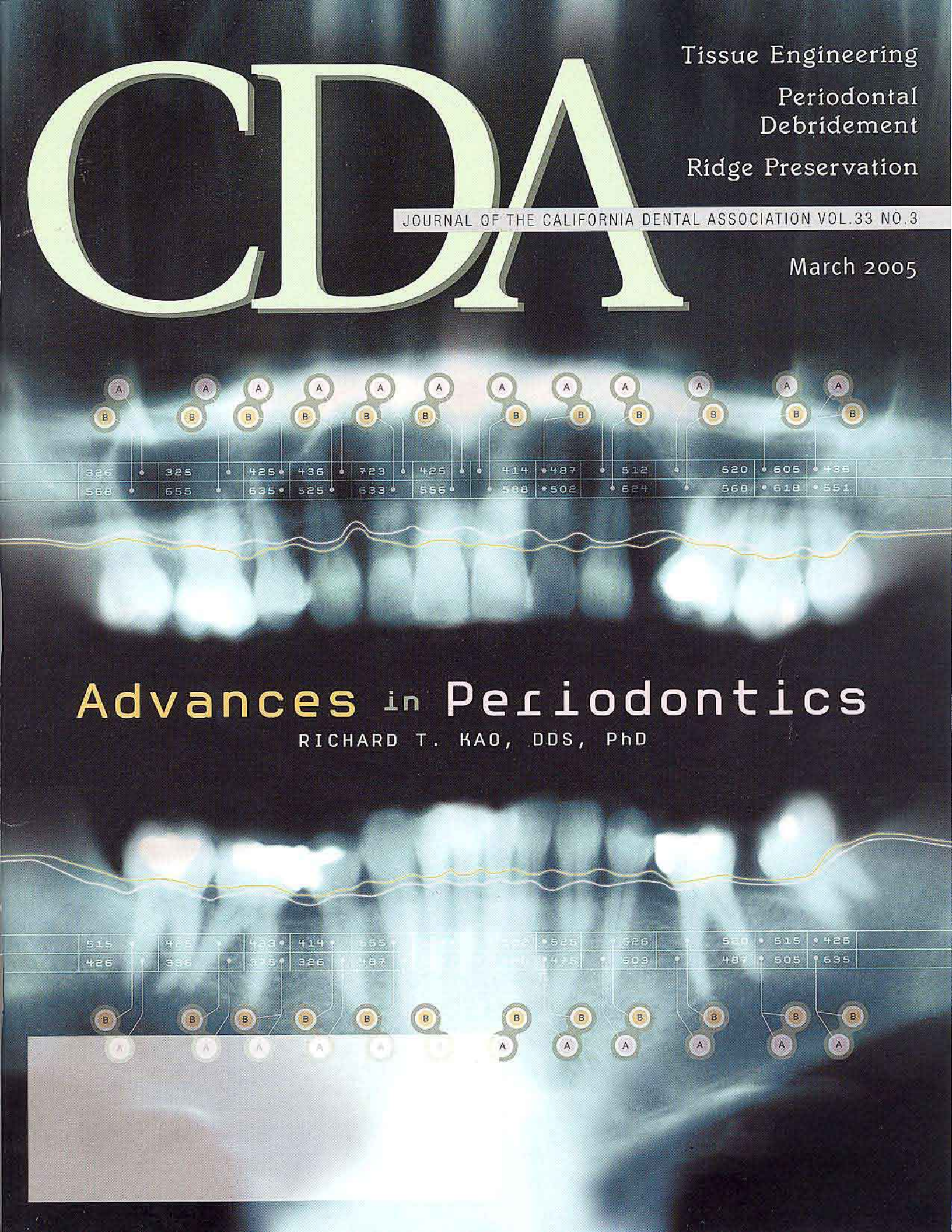
Tissue Engineering

Periodontal Debridement

Ridge Preservation



Advances in Periodontics

RICHARD T. KAO, DDS, PhD

OF THE CALIFORNIA DENTAL ASSOCIATION
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DEPARTMENTS

FEATURES

Alan L. Felsenfeld, DDS

Do Your Own Thing

A litany of buzzwords is associated with the political aspects of dental care, but among the more popular is access. Access to dental care is a significant problem in parts of our state, as well as across the nation. The reasons for the inability of a patient to receive adequate oral health care might be financial, in that, the poorest populations, who do not or cannot enroll for available low-income programs, have little ability to receive care under any circumstances. In addition, there are individuals who cannot qualify for state-funded programs because their family income exceeds the maximum amount of dollars that can be earned and still receive benefits. Finally, there are areas within our state where there is no access to dental offices, despite patients' ability to pay for care.

There is no question that diminishing the problem or eliminating access issues in their entirety is a high priority for dental societies and associations throughout the state and across the country. More importantly, politicians consider access to care a high priority in serving their constituents, or at least they articulate that concern.

In recent months, there has been a significant amount of effort spent on the delivery of health care to Alaska natives living in the most remote parts of that state, including a suggestion that a cadre of technically trained dental health aide therapists be developed. These individuals would be able to provide routine dental care to students in schools — such as fillings and simple tooth extractions. This program has been compared to the New Zealand dental nurse program, which has been in operation for many years. As might be expected, organized dentistry at the national level was quite concerned about this program, arguing that these individuals would be poorly trained to perform irreversible dental procedures.

Some of the points raised against the Alaska dental therapist concept of delivery proposed the notion that dentistry is a profession and not a trade. While one could suggest that a technically trained person could be taught to restore a tooth, the need for a broad science background and the preclinical education received in dental schools allow that person to be a doctor, not merely a technician. To train individuals to do dentistry without the ability to properly assess patients and understand the biological implications of dental treatment was considered inappropriate.

Within our state, we have problems similar to Alaska and other areas with large underserved populations. Several politicians have proposed different mechanisms for solving these problems. One such program was proposed and enacted in AB 1116 by former Assemblyman Fred Keeley. This law enables the Dental Board of California to "approve" dental schools in other countries as being equivalent in the education of their own dentists to allow their graduates to ultimately practice dentistry in California after passing the licensure examination. One such school has al-

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We have a well-established and respected system in place to ensure quality of our schools and training programs, and we should continue to use it to maintain a high level of education, regardless of the country of origin.

ready been approved in Mexico, so five of their graduates who have completed an "equivalent curriculum" can sit for licensure in California and, if successful, practice anywhere in the state. The regulation is in place and in four years, the first applicants from that institution may arrive to take the examination.

Assemblyman Marco Firebaugh had AB 1845 enacted to allow 30 individuals, who are graduates of a designated school in Mexico, to practice in underserved areas with a limited license, provided they did so under the supervision of a California-licensed dentist. The law has not been implemented since the individuals from this school needed remediation to bring them up to the standards of California dentistry, according to a survey team sent by the Legislature. Financing this project has been extremely limited, and the dentists are not coming at this time.

At the recent House of Delegates of the American Dental Association, a resolution was discussed that would empower the Commission on Dental Accreditation to go to foreign countries and, using standards that are applicable to United States schools, accredit foreign institutions. As one would expect, this issue was hotly discussed and debated. Regrettably, after much political argument and negotiation, the resolution was diluted to allow for "evaluation and consultation" to those schools without the accreditation credential. Clearly, this defeats the purpose of the resolution, but appeared to be a point of agreement between opposing sides of the issue. It is unlikely that any schools will spend the money to have this process without the possibility of accreditation.

One contention proffered against the accreditation of foreign dental schools by the commission, was that the standards of education as applied for the accreditation process were minimal, and the accreditation of other nation's schools would not produce the same level of competent practitioners in our country. Another argument against the commission having responsibility for foreign school accreditation was that options for foreign-trained dentists to achieve licenses in the United States were available. In California, all five schools offer a two-year program for foreign-trained individuals to receive a degree.

So what's the problem? The two-year dental programs for foreign graduates in our schools are good, and all the schools have worked hard to develop curricula that will ensure that quality dentistry is being performed on patients here. Unfortunately, in only two years, the emphasis, by necessity, needs to be on performance — to ensure these students are practicing "technical" dentistry at the same level as our American graduates. There must be sacrifice of some of the basic science portions of the curriculum to allow for completion within the two years. While these individuals are required to pass Part I of the national boards, doing so is not necessarily an indicator of their overall basic understanding of science. The programs are good, the individuals coming out of them seem to be well-trained, and the quality dentistry does not appear to be compromised. However, with the two-year programs, we are only emphasizing the technical aspects of practice.

Again, so what's the problem? The argument that the standards of the Commission on Dental Accreditation are minimal, merely shows that the individuals who espouse that philosophy are not involved in accreditation surveys at any level. Be confident that the standards are developed by educators and clinicians who have set the bar at an extremely high

level. The site visits generate significant introspective study of the institutions to assure quality of education at the highest level.

Let us look at the system, as it exists today. If an individual graduates from dental school in Mississippi or Washington, and desires to practice in California, that person can take a dental licensing examination based on graduation from a school accredited by the commission in the original state. The standards set by the commission and met by the school are acceptable by all states for licensure. Those who oppose the commission accrediting foreign dental schools are not opposed to the above system; it is what is in place today and works well. If a foreign school meets all the same strict criteria as American schools, then what is the difference? Once again, I am compelled to ask what the problem is. I don't get it … or do I?

We have a well-established and respected system in place to ensure the quality of our schools and training programs, and we should continue to use it to maintain a high level of education, regardless of the country of origin for dentists who practice in not only California, but in all of the United States. If a school meets the criteria for accreditation, its graduates should be able to practice anywhere.

The Dental Board of California does not desire to be — nor is it equipped to be — in the business of accreditation. The American Dental Association needs to support the accreditation of foreign dental schools by the commission. Last year, they missed an opportunity to elevate dentistry to an even higher level. One would hope that they will rethink the issue this year. CDA

Amalgam and Environmental Agencies

I would like to add a few comments to that of Dr. Kao to the letter of Dr. John W. Burk in the November *Journal* issue on amalgam and environmental agencies.

The EPA has also placed severe restrictions on mercury in biosolids or sludge in treatment plants. This is one reason regulators do not confine their activities to incineration only. As for crematoriums, it is my understanding that they are supposed to have a type of filtered device installed to capture mercury vapor.

Dr. Burk asks why the EPA "gets away with classifying amalgam as 50 percent hazardous mercury." I agree that this error is a constant frustration for us. Unfortunately, many dentists will define amalgam as "50 percent mercury." Our members should remember their metallurgy.

An amalgam by definition is any metal mixed with the metal mercury. An alloy is a mixture of two or more metals that afterward exhibits characteristics entirely different from its component metals. Silver amalgam is also an alloy. While it is true that the starting mix of this material is approximately half and half mercury and other metals, the resultant material is an inert alloy with entirely different properties than either silver or mercury.

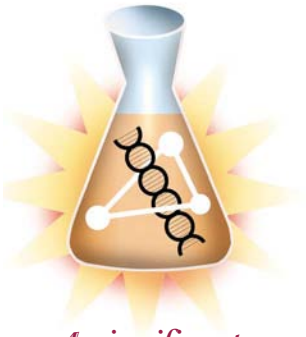
Donna B. Hurowitz, DDS
San Francisco

Illustration: Dan Hubig

Tooth Regeneration and Transplantation: Fiction or Future?

By Stacey M. Woo

The day may come when a patient can visit his or her oral and maxillofacial surgeon and get a real, live tooth transplanted into his or her mouth. Scientists are one step closer to creating teeth for transplantation through stem cell-based tissue engineering and understanding the key environmental and molecular signals of tooth development. In the July 2004 issue of the *Journal of Dental Research*, Paul Sharpe and colleagues at King's College in London described how they cultured mouse nondental stem cells, stimulated expression of odontogenic markers, induced tooth bud development, and transplanted the tooth buds into adult bone, where they continued to develop.[1]



A significant note is that the teeth created in these experiments did not progress past the tooth bud stage to develop roots.

Stems cells are multipotent cells that can self-renew, can differentiate, and are necessary for homeostasis and tissue repair. Stem cells are derived from embryos, fetuses, and adults. Stem cells are of great interest to scientists for their regenerative potential. A major aim of stem cell research is to harness and manipulate this potentiality through plasticity, reprogramming, or fusion to engineer tissues in the laboratory. In dentistry and oral and maxillofacial surgery, stem cell-based tissue engineering has countless potential applications in restoring lost tooth structure, regenerating lost bone and periodontium, and restoring teeth missing from trauma or genetic defects like hypodontia.

Teeth develop from sequential interactions between oral epithelium and underlying mesenchymal tissue via secreted signaling proteins that induce gene expression and regulate the cellular phenotype at each development stage. Studies have well documented that the source of these signals shifts between the oral epithelium and mesenchyme depending on the developmental stage. Studies have also shown that the transcription factors MSx1 and Pax9 are required in early tooth development. In this study, Sharpe et al. cultured various stem cell types in contact with embryonic oral epithelium. Three sources of stem cells were used: mouse embryonic stem cells (which have the potential to form dental cells), mouse neural stem cells (which are not expected to form dental cells), and adult mouse bone marrow cells (nondental cells with unknown potential). These scientists showed stem cell expression of odontogenic molecular markers MSx1, Pax9, and Lhx7 upon culture with mouse oral epithelium. Stem cells grown with oral epithelium started to express markers characteristic of tooth-forming cells.

Furthermore, transplantation of each recombination type to an ectopic site (under the renal capsule) for 12 days resulted in bone and soft tissue formation. The bone marrow-derived recombinant transplants grew the best, and histology revealed tooth bud-like tissue formation, including an ameloblastic cell layer, an adjacent enamel layer, newly formed dentin, and an odontoblastic cell layer. The layer arrangement was consistent with normal tooth bud development, and was surrounded by newly formed bone and organized connective tissue. Adjunct experiments proved that the cells of the newly-formed bone and dental tissue were derived solely from the transplant rather than the surrounding host tissues or oral epithelium.

Next, Sharpe and colleagues conducted an experiment to see if embryonically derived tooth primordia could develop into a tooth when transplanted to its appropriate site in the adult jaw bone. They extracted a tooth bud from a mouse embryo and implanted it in an adult mouse for 26 days. Histology showed ectopic tooth formation with dentin, enamel, ectopic bone, and soft connective tissue.

A significant note is that the teeth created in these experiments did not progress past the tooth bud stage to develop roots. While histology demonstrated normal formation of ameloblasts, enamel, dentin, predentin, odontoblasts, bone, and connective tissue in both ectopic transplant experiments, there was no evidence of root sheath or cementoblast formation. This shows that further research is required to elucidate the key signals for root development and to manipulate those signals in the stem cell transplants. Additionally, Sharpe did not show if the ectopically grown tooth buds from the renal capsule would continue to develop if transplanted into the appropriate site in the adult jaw bone. This should be the aim of future research.

The work of Sharpe and colleagues signifies a major step in dental tissue engineering because it demonstrates that nondental embryonic stem cells can be transferred to an adult and develop into dental tissues if given the appropriate signals. This has direct clinic relevance to dentists and oral and maxillofacial surgeons who treat patients suffering from loss of teeth and tooth structure.

Even today, treatment options for replac-

ing missing teeth and restoring lost tooth structure have limitations. Although dental implants are a significant improvement over dentures and bridges in the treatment of missing teeth, dental implants often have esthetic, surgical, and functional limitations that affect prognosis. Dental implants are not appropriate for everyone. Even patients with successful dental implant therapy, now considered the standard of care for tooth replacement, lack the proprioception they once had with their natural teeth. Dental implant placement is also limited by bone quality and quantity. Understanding key genetic interactions controlling tooth development and translational research aimed at real therapies may lead us to create transplantable teeth for tooth replacement therapy. In theory, a transplantable, biologically compatible tooth would be preferable to dental implants because they would develop into a tooth as well as its associated bone, ligaments, and soft tissue. It would take dentistry into a new era.

Reference / **1.** Ohazama A, Modino SA, Miletich I, Sharpe PT, Stem-cell-based tissue engineering of murine teeth. *J Dent Res* 83(7):518-22, 2004.

Author / Stacey M. Woo is a senior dental student at the University of California at Los Angeles School of Dentistry.

Matrimony May Have Health Benefits

A new report from the Centers for Disease Control and Prevention suggested that married adults are healthier than their widowed, divorced, or never-married counterparts.

The report, *Marital Status and Health: United States, 1999-2002*, was based on interviews with 127,545 adults 18 years and older as part of the National Health Interview Survey, conducted by CDC's National Center for Health Statistics.

The study looked at health conditions, status and limitations, and health-related behaviors according to marital status and by age, race/ethnicity and socioeconomic factors, including education and poverty status.

Among the findings, nearly 60 percent of adults are married; 10.4 percent are separated or divorced; 6.6 percent are widowed; 19 percent never married; and 5.7 percent live with a partner. Marital status varies greatly among race/ethnic groups: Approximately 61 percent of white adults; 58 percent of Hispanic adults; and 38 percent of black adults are married, according to the survey.

Married adults are less likely than other adults to be in fair or poor health, and are less likely to suffer from health conditions such as serious psychological distress and headaches. Married adults are less likely to be limited in various activities, such as work and other activities of daily living.

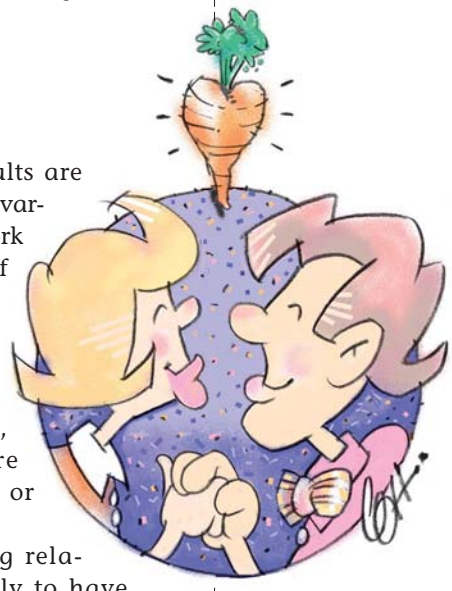
Married adults are less likely to drink heavily, smoke, or be physically inactive. However, married men are more likely to be overweight or obese than other men.

Adults in cohabiting relationships are more likely to have health problems than married adults and more closely resemble divorced and separated adults.

The relationship between marital status and one's health is most striking in the youngest age group, although it persists throughout the age groups studied.

While the results reflect that married adults are generally in better health than those who are unmarried, the reasons for better health status among married adults cannot be determined with the cross-sectional data collected in the National Health Interview Survey.

The report, *Marital Status and Health: United States, 1999-2002*, is available at the CDC/NCHS web site, www.cdc.gov/nchs.



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Dentists Can Push For Businesses to Adopt Direct Reimbursement

Dentists who want area employers to use direct reimbursement method of providing their employees with a dental benefit should take the initiative and discuss the issue with local company benefits managers.

Many business owners and benefits managers don't think much about their dental plans because they have no evidence there's a problem, wrote Michael D. Fisher, DDS, in the Fall 2004 issue of *Northwest Dentistry*, Minnesota Dental Association's journal.

If there are no employee complaints, then there must be no problem, they believe, according to the article. However, a discussion with the employees about their benefits the savings to employers that can come from adopting a direct reimbursement policy, often leads to a changed perspective for many business owners, Fisher said.

Dentists know a lot of owners of small and mid-sized businesses, by virtue of their place in the community, Fisher said adding they should use this network to their advantage by talking up the benefits of direct reimbursement and getting local business owners or decision makers in touch with the local dental society to learn more.

Financial Advisers: Medical Professionals Face Four Major Money Pitfalls

While most medical professionals know full well what to do behind a stethoscope, microscope or scalpel, many do not know how to operate when it comes to their personal financial matters.

"Some of the personality traits that are necessary to make medical professionals truly outstanding in their field — the ability to make snap decisions, shouldering the responsibility for hard choices and a well-developed sense of confidence — can be downright counterproductive when it comes to handling personal finances. These traits tend to work against doctors and surgeons who are too quick to assume that they can 'figure out' their financial picture for themselves," said Gregory Carlson, president of Carlson Capital Management in Minneapolis and Northfield, Minn.

Carlson's company, along with Petersen Hastings Investment Management in Kennewick, Wash., and J.E. Wilson Advisors of Columbia, S.C., are fee-only investment advisers who recently outlined four main pitfalls common to medical pros and offered their advice. The companies are members of the Zero Alpha Group.

"I would never think of performing a medical procedure, but there is no shortage of medical professionals who mistakenly think they know enough about money to handle their own complex financial situations," said Scott Sarber, vice president of Petersen Hastings Investment Management. "We sometimes find doctors that are up to their necks in the most bizarre financial schemes imaginable."

A majority of the Zero Alpha Group specialize in providing financial advisory services to doctors, surgeons and other medical professionals.

The four most comment financial pitfalls for medical professionals, according to the Zero Alpha Group:

■ Investing in the hot new drug. Physicians are bombarded every day by pharmaceutical reps touting the next "big" drug. Doctors frequently make the mistake of believing that a new medicine currently experiencing heavy sales will translate into a higher stock price.

"In nearly every case, the price of a drug company's stock already reflects what their new drug offering is going to do in the marketplace," Sarber said.

■ Obsessing about "cheap" debt. A typical physician leaves medical school nearly $100,000 in debt.

"Education debt tends to be loaned at an incredibly low rate, usually below 5 percent," Carlson said. "This is manageable debt – it shouldn't be paid off while other more expensive debt piles up or while some of that money could be earning more in long-term financial plan. Other medical professionals often move in the opposite direction and start using expensive credit to accumulate cars, real estate, and other toys.

■ Overcomplicating things. Many physicians often are inundated with offers for complicated, sometimes even questionable, investment schemes to keep their money safe from malpractice settlements and other financial difficulties. Most do not need expensive plans for asset protection.

"You need an astronomical level of assets for the upkeep costs of offshore monies," said James Wilson, president of J.E. Wilson Advisors. "Most doctors don't need that."

■ Running out of time. In the American workforce, physicians are some of the busiest people. Setting aside time to sit down with an investment adviser can difficult, but it is necessary.

Smog, Rising Heat Trigger Surge in Allergies, Asthma

Millions of poor and minority children living in America's cities are likely to suffer higher rates of asthma resulting from elevated levels of pollen and changes in the types of molds spurred by global warming. Unhealthy urban air masses, caused by cars, trucks and buses burning fossil fuel, also is a contributing factor, according to a warning issued recently by Harvard researchers and the American Public Health Association.

The Harvard report stated, "Rising levels of carbon dioxide, in addition to trapping more heat, promote pollen production in plants, increase fungal growth, and alter species composition in plant communities by favoring opportunistic weeds (like ragweed and poison ivy). Other emissions from burning fossil fuels in cars, trucks and buses form photochemical smog that causes and exacerbates asthma, while diesel particulates help deliver and present pollen and mold allergens to the immune system in the lungs. The combination of air pollutants, aeroallergens, heat waves and unhealthy air masses — increasingly associated with a changing climate — causes damage to the respiratory systems, particularly for growing children, and these impacts disproportionately affect poor and minority groups in the inner cities."

"This is a real wake-up call for people who mistakenly think global warming is only going to be a problem way off in the future, or that it has no impact on their lives in any meaningful way," said Christine Rogers, PhD, senior research scientist, Exposure, Epidemiology and Risk Program at the Harvard School of Public Health. "The problem is here today for these children, and it is only going to get worse. These children get hit with a powerful one-two punch: exposure to the worst air quality problems and the additional allergen exposure arising from global warming. In addition, global warming is causing pollen seasons to arrive earlier in the spring."

The problem is particularly critical since asthma among preschool children has already reached epidemic levels, having grown 160 percent between 1980-1994, more than twice the rate, 75 percent, for the overall U.S. population, according to *Inside the Greenhouse: The Impacts of CO_2 and Climate Change on Public Health in the Inner City*, a report released by the Center for Health and the Global Environment at Harvard Medical School. Low-income and African-American toddlers, a large share of who live in the inner cities, have the highest incidence rate of asthma.

"All Americans living in our cities are at increased risk of respiratory disease due to greater concentrations of air pollution, soot and ozone, in urban environments. But it's our children who are at greatest risk. This is a public health issue and it is a health disparities issue. Low-income communities receive less treatment for environmental disease because they have less access to health care, yet are often at much greater risk from their environment," said George C. Benjamin, MD, executive director, American Public Health Association.

According to the new report, the U.S. Centers for Disease Control and Prevention estimates the prevalence of asthma in the American adult population is approximately 7.5 percent, or 16 million. The cost in the U.S. for treating asthma in those younger than 18 years of age is estimated at $3.2 billion per year.

"The good news is that we already have the answers about what to do," said Paul R. Epstein, MD, MPH, associate director, Center for Health and the Global Environment, Harvard Medical School. "Local initiatives on individual, organizational, city, state and regional levels can go a long way toward making things better. Converting from fossil fuel use to greater energy efficiency, hybrid vehicles, alternative sources, 'green buildings,' and improved public transport would reduce CO_2 levels now altering plant growth and help to stabilize the climate."

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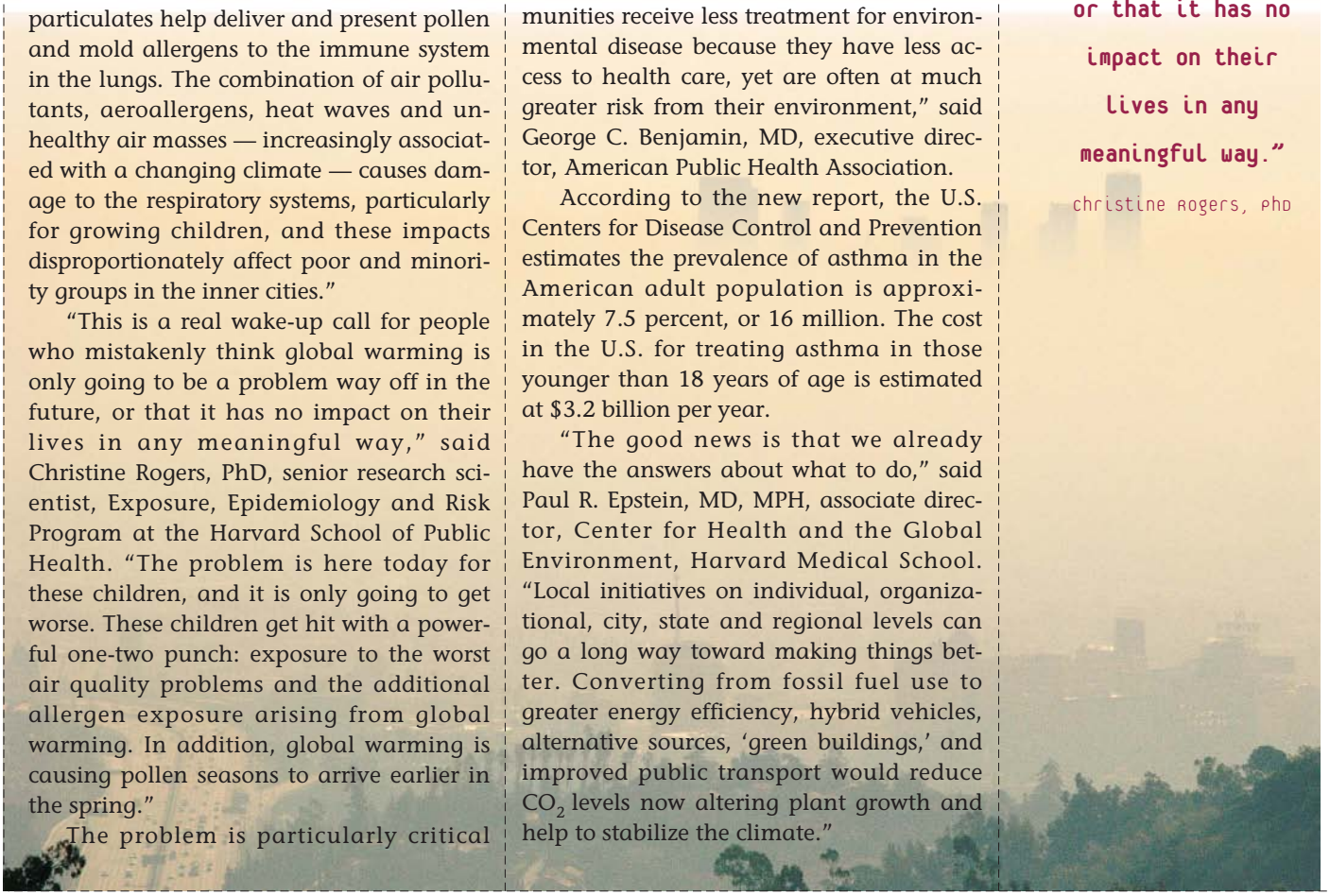
christine rogers, phd



Pneumonia in Elders May Be Linked to Dental Plaque

Nine pathogens, present in the lungs of elderly patients who developed hospital-acquired pneumonia, also were discovered in dental plaque samples taken from the same patients. These findings bolster previous research linking the two afflictions, reported scientists at State University of New York at Buffalo.

Pneumonia ranks the second most frequently acquired infection in hospitalized patients. It affects as many as 25 percent of all patients admitted to the intensive care unit who are placed on ventilators.

The team of scientists evaluated 49 nursing home residents who were admitted to the ICU and required respirators. Each patient was assigned a dental plaque score based on an oral examination, while plaque samples were collected to establish what types of bacteria were present. Twenty-eight patients had respiratory pathogens in their dental plaque.

Of the 49 patients in the study, 14 developed pneumonia, including 10 from the respiratory pathogen group. Fluid samples showed that of the 13 pathogens isolated from the patients' lungs, nine were genetically identical to pathogens recovered from the patients' dental plaque samples.

"These findings indicate that dental plaque is a reservoir of respiratory pathogens that can cause pneumonia in hospitalized institutionalized elders," said lead author Ali A. El-Solh, MD, MPH, associate professor of medicine in the university's School of Medicine and Biomedical Sciences. "We need to investigate the relationship between the burden of dental disease and the incidence of respiratory events.

"In the meantime, nursing homes and other institutions housing frail elderly should be involved actively in improving daily oral hygiene of their residents and enhancing access to dental care," El-Solh added.

Complete results from the study are published in the November 2004 issue of *Chest*.

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ALI A. EL-SOLH, MD, MPH

Upcoming Meetings

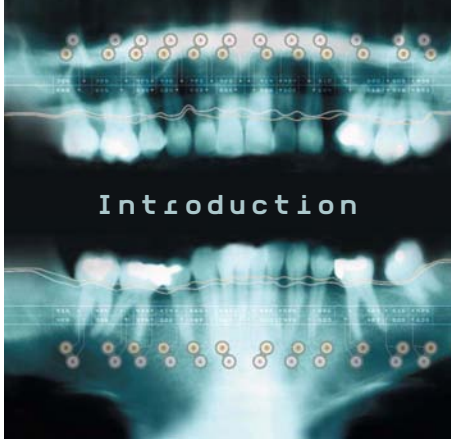
2005

March 17-19	Thomas P. Hinman Dental Meeting, Atlanta, (404) 231-1663.
April 6-9	Academy of Laser Dentistry 12th Annual Conference and Exhibition, New Orleans, (954) 346-3776.
April 12-16	International Dental Show, Cologne, Germany, www.koelnmesse.de
May 12-15	CDA Spring Session, Anaheim, (866) CDA-MEMBER (232-6362).
Aug. 17-20	Sixth Annual World Congress of Minimally Invasive Dentistry, San Diego, (800) 973-8003.
Sept. 9-11	CDA Fall Session, San Francisco, (866) CDA-MEMBER (232-6362).
Oct. 6-9	ADA Annual Session, Philadelphia (312) 440-2500.

2006

Oct. 16-19	ADA Annual Session, Las Vegas, (312) 440-2500.

To have an event included on this list of nonprofit association meetings, please send the information to Upcoming Meetings, *CDA Journal,* P.O. Box 13749, Sacramento, CA 95853 or fax the information to (916) 554-5962.



Spirit of Our Profession

Richard T. Kao, DDS, PhD

As guest editor for this issue of the *Journal*, I take great pleasure in informing our readers of the advances that have occurred in the discipline of periodontics. Like many previous issues, the final result is an eloquent description of new and evermore glitzy techniques that make our specialty the best at what it does. Indeed, there have been several new advances which Dr. Gordon L. Douglass, our recent past American Academy of Periodontology president, will introduce and put into perspective in the first article. However, these technological advances do not and cannot replace the spirit of our periodontal profession which allows us to better serve our patients, work with our colleagues, and advance our branch of learning, science and technique.

I was recently reminded of this spirit by the passing of one of my mentors, Dr. Ivan D. Ancell of Hayward, Calif. At his memorial service, I remember walking more than two blocks on a cold afternoon because the church was overflowing with people who came to remember and pay their respects to his memory. And it was at that service that I gained renewed appreciation as to why our periodontal specialty is different.

Ivan grew up as an Iowa farm boy, went to dental school at the University of Iowa, served his public health service tour in the impoverished neighborhoods of Philadelphia, and finally attended the University of Pennsylvania for his periodontal training. During this time, he learned to be passionate about his profession. Ivan and his wife, Mary, traveled to the Bay Area and he subsequently established a practice in the blue-collar town of Hayward. I often asked him why he set up in that area, and he would simply answer that these were the type of patients he felt he was akin to. At his memorial service, many of his patients from his 34 years of practice came up and spoke of his friendship, good humor, generosity, and caring nature. When one considers that probably more than half of the church was filled with his patients, who took time out to pay their respects, it dawned on me we are the only specialty privileged enough to develop a long-term care relationship with our patients. Along with the general dentists, we work to not only maintain their health, but we get to know these patients. Ivan was a master at this, for he always had time to listen to everyone's life experiences — good and bad. There was always time for a joke or a story to cheer people up. Often times, he was a better diagnostician because he appreciated patients as people and listened to what they told him. Ivan was able to educate people on the role of stress and diabetes on their dental health. Most importantly, these people saw Ivan not as a caregiver but as a caring "friend."

Dr. Ivan D. Ancell

At this service, many of Ivan's professional colleagues came and spoke fondly of his contributions. Many of his referring general dentists spoke not only of his humor, but also of his mannerism of asking, "What do you think about

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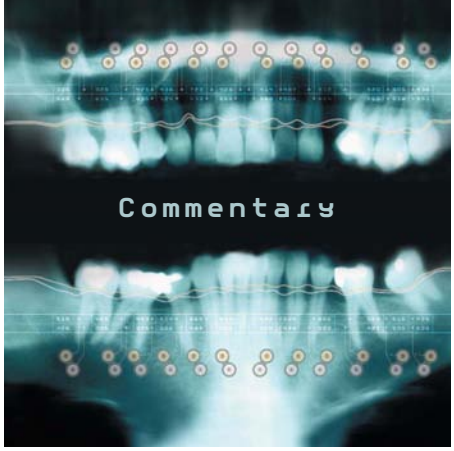
all this?" In his own style, he not only worked with his doctors, but also uplifted their appreciation of their patients' dental health problems. Fellow periodontists and specialists in the region spoke of his constant willingness to help and to cover for emergency care. This spirit of good humor, cooperativeness, and seeking a higher level of "team dentistry" is a hallmark of our profession. This spirit is the basis of multidisciplinary care.

Also at the service were Ivan's students and fellow instructors. Along with practicing 5½ days a week in a clinical setting, Ivan spent every Monday afternoon as a volunteer faculty member at University of California, San Francisco. I was but one of his many students. Most will remember him not merely as a teacher, but as someone who constantly asked you how you can be better, not only as a caregiver, and as a surgeon, but as a person. When things were going wrong, he would give you just the right balance of sympathy and then nudge you to move ahead and take on new challenges. Ivan read prolifically and was often quite modest about his knowledge. He would never tell you that you were wrong, but ask you Socratic questions about how it could have been better or how it could have been different. Our profession continues to produce good clinicians, thanks to dedicated teachers like Ivan.

As I reflect on how the periodontal profession is taking on more "incident-based" treatment, i.e. implant placement, gingival grafting, and crown lengthening, I am gravely concerned we are losing the spirit that mentors like Dr. Ivan Ancell taught us. Perhaps this is a lesson not only for the periodontal profession, but also for dentistry as a whole. We should not be lost in the glitz of new techniques, but remember what makes dentistry unique as a profession, is that we have the potential to develop a patient relationship that has no rivals in health care. We can enjoy our comradeship with our colleagues, and contribute to our own professional future while instilling enthusiasm and passion to our "dental neophytes."

Thank you Ivan, for this is another lesson you taught me. CDA



Periodontics – Tissue Engineering and the Future

Gordon L. Douglass, DDS

ABSTRACT

Periodontics has a long history of utilizing advances in science to expand and improve periodontal therapies. Recently the American Academy of Periodontology published the findings of the Contemporary Science Workshop, which conducted state-of-the-art evidence-based reviews of current and emerging areas in periodontics. The findings of this workshop provide the basis for an evidence-based approach to periodontal therapy. While the workshop evaluated all areas of periodontics, it is in the area of tissue engineering that the most exciting advances are becoming a reality.

Today, the emergence of biologics, agents that stimulate a true regeneration and reconstruction of the tissues to their original form, are becoming the new horizon in periodontics. In the past, we have had agents which facilitate healing but offer minimal osseoinductive effects such as demineralized freeze-dried bone allograft and platelet-rich plasma, which offer low levels of bone morphogenic proteins and low levels of platelet-derived growth factors, respectively. However, the levels offered by these substances, in most cases, are too low to truly induce regeneration, even though both may facilitate bone healing by being osseoconductive and mechanically improving the wound healing. Presently there are two biologics commercially available, enamel matrix derivative or Emdogain (Staumann Biologics, Boston) and recombinant human platelet-derived growth factors or GEN21F. (Osteohealth Co., Shirley, N.Y.).

Enamel matrix derivative stimulates the regeneration of new cementum and periodontal ligament fibers on the root resulting in the regeneration of a

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new attachment of the tooth with the adjacent bone and connective tissue. Strong evidence has shown it will improve current osseous grafting techniques, and emerging evidence has shown that it improves the regeneration of a new attachment with periodontal plastic surgery procedures, such as gingival grafting. The recombinant platelet-derived growth factors have been shown to induce osseous regeneration of periodontal defects when placed with tri-calcium phosphate as a carrier that is rapidly resorbed (see Dr. Richard Kao's paper "Tissue Engineering for Periodontal Regeneration" on Page 205).

The true regeneration induced by these biologics should not be confused with the repair that may result from more traditional mechanical procedures such as root planing, curettage, flap curettage or flap surgery. No matter what device is used — curet, scalpel, laser, etc. — the result is the same, a repair that may result in a significant improvement of the tissues, but not in a true regeneration of the tissues that is indistinguishable from the original.

Additionally, there are other biologics on the horizon (such as recombinant bone morphogenic proteins) which, as they become available for commercial use, will continue to expand our options. The development of improved delivery techniques will allow the biologic agent to remain in the healing wound which will increase the tissue response. Recently, Giannobile and coworkers reported the use of gene-transfer as a technique to deliver a time-released dose of platelet-derived growth factors to osseous periodontal defects. As tissue engineering continues to grow, not only will the list of biologics increase, but innovative delivery systems will be developed. If history continues, these tissue engineering techniques for regenerating periodontal defects will become the new basis for regeneration of the alveolus and the placement of dental implants.

These first steps into the frontier of tissue engineering provide an exciting and promising future for periodontics and dentistry. CDA

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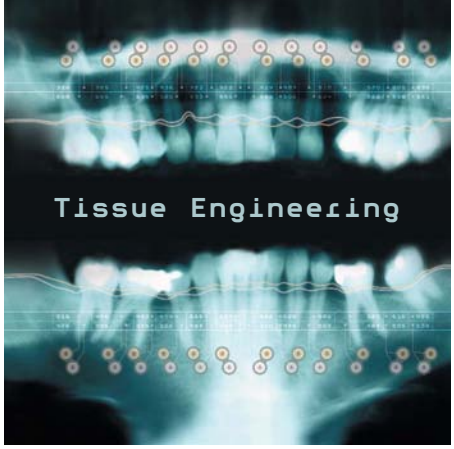

Tissue Engineering for Periodontal Regeneration

Richard T. Kao, DDS, PhD; Greg Conte, DDS; Dee Nishimine, DDS; and Scott Dault

ABSTRACT

As a result of periodontal regeneration research, a series of clinical techniques have emerged that permit tissue engineering to be performed for more efficient regeneration and repair of periodontal defects and improved implant site development. Historically, periodontal regeneration research has focused on a quest for "magic filler" material. This search has led to the development of techniques utilizing autologous bone and bone marrow, allografts, xenografts, and various man-made bone substitutes. Though these techniques have had limited success, the desire for a more effective regenerative approach has resulted in the development of tissue engineering techniques. Tissue engineering is a relatively new field of reconstructive biology which utilizes mechanical, cellular, or biologic mediators to facilitate reconstruction/regeneration of a particular tissue. In periodontology, the concept of tissue engineering had its beginnings with guided tissue regeneration, a mechanical approach utilizing nonresorbable membranes to obtain regeneration in defects. In dental implantology, guided bone regeneration membranes ± mechanical support are used for bone augmentation of proposed implant placement sites. With the availability of partially purified protein mixture from developing teeth and growth factors from recombinant technology, a new era of tissue engineering whereby biologic mediators can be used for periodontal regeneration. The advantage of recombinant growth factors is this tissue engineering device is consistent in its regenerative capacity, and variations in regenerative response are due to individual healing response and/or poor surgical techniques.

In this article, the authors review how tissue engineering has advanced and discuss its impact on the clinical management of both periodontal and osseous defects in preparation for implant placement. An understanding of these new tissue engineering techniques is essential for comprehending today's ever-expanding oral plastic surgery procedures.

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The classic approach to periodontal regeneration in the last 30 years has been the use of bone grafts or substitutes to repair periodontal defects. The literature contains several excellent reviews on the use of autografts, allografts, and alloplastic graft materials.[1-3] In this section, a summary of bone grafting is provided.

Early clinical series reported that bone regeneration was enhanced by the use of cancellous bone autografts from the iliac crest and intraoral bone marrow. To date, iliac bone and marrow have the most osteogenic and regenerative potential, and are one of two graft materials with the reported ability to regenerate the periodontium horizontally or with "0-wall" defects. Autografts can effectively enhance bone fill by an average of 3 mm to 4 mm. To date, this is considered the "gold standard" for periodontal graft material. While autografts have proved clinically successful, they have become less popular for periodontal regeneration due to the necessity of a secondary surgical harvest site and surgical complications of ankylosis and root resorption. Recently, however, there has been renewed interest in autografts for implant site development in the form of block grafts and particulates to augment composite grafts used in ridge and sinus augmentation procedures.

During the last decade, the demineralized and mineralized freeze-dried bone allografts (DFDBA and FDBA) have become the regeneration material of choice. In addition to its availability and putative osteogenic potential, various clinical studies indicate that 2 to 3 mm of bone fill are possible with demineralized and mineralized freeze-dried bone allografts. However, recent studies have questioned the osteogenic potential of bone allografts, suggesting that this may vary depending on the bone bank or batch within the bank used, processing procedures utilized, and donor characteristics.

Alternatively, a variety of xenograft and alloplastic grafting materials have become available for use in periodontal repair. Alloplastic bone grafts consist of ceramics, such as hydroxyapatite (HA), porous hydroxyapatite (PHA), tricalcium phosphate (TCP), and biocompatible composite polymers (HTR). These inert biological fillers have been shown to be osteoconductive, safe, and well tolerated. Although no new periodontal regeneration occurs with the use of these fillers, healing is enhanced and a decrease in probing depth occurs through the formation of a long junctional epithelium. Presently, these materials are used in procedures, such as ridge preservation and ridge augmentation; however, they are of limited effectiveness in treating osseous defects.

If mesenchymal cells from the periodontal ligament or perivascular region of the bone proliferate and colonize the root surface, regeneration occurs.

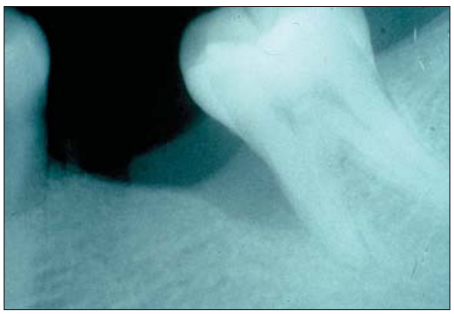
Anorganic bovine bone is bovine bone that has been chemically treated to remove its organic components, leaving a trabecular and porous architecture similar to human bone. It has been proposed that while this bone has no osteoinductive properties, it acts as a scaffold for new bone formation. This graft material has been shown to be osteoconductive in correcting defects and can serve as scaffolding to support guided tissue regeneration. This is becoming a popular graft material for ridge preservation and sinus augmentation. With the exception of autografts, most of the materials discussed are used as scaffolding to support tissue engineering techniques.

Guided Tissue Regeneration

Current understanding of periodontal healing is based on a hypothesis by Melcher, who proposed that the cell type which repopulates the exposed root surface at the periodontal repair site will define the nature of the attachment or repair that takes place.[4] If mesenchymal cells from the periodontal ligament or perivascular region of the bone proliferate and colonize the root surface, regeneration occurs.

Alternatively, if lost tissue is replaced by the surrounding tissue to form a scar, repair occurs. The anatomy of the scar is dependent on the cell types that predominate the defect. The four cell types are gingival epithelial cells, mesenchymal cells from gingival connective tissue, alveolar bone cells, and periodontal ligament cells. If epithelial cells proliferate along the root surface, a long junctional epithelium will result. If gingival connective tissue populates the root surface, a connective tissue attachment will form and root resorption may occur. If bone cells migrate and adhere to the root surface, root resorption and ankylosis occur. Guided tissue regeneration utilizes a mechanical barrier to selectively enhance the establishment of periodontal ligament and perivascular cells in osseous defects to initiate periodontal regeneration. In a series of classical animal and human studies, Melcher's hypothesis was confirmed.

Much of our current understanding of guided tissue regeneration is based on studies utilizing expanded polytetraflouroethylene (ePTFE) membranes. Although they are used less frequently



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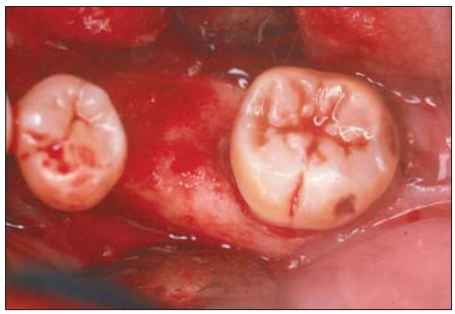

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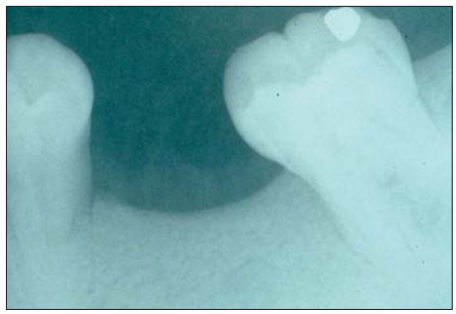

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Figure 1. Radiographs of a guided tissue regeneration case utilizing a nonresorbable ePTFE membrane. The mesially inclined molar is associated with a three-walled intraosseous defect (**Figures 1a-b**). The defect was filled with demineralized and mineralized freeze-dried bone allografts, and ePTFE was used. Membrane was exposed after eight weeks and removed two weeks later. Radiographic "fill" was halfway after six months and maximum fill was present after 12 months (**Figure 1c**) with minimal probing depth.

now, they are still popular for guided bone regeneration and ridge preservation so it is important to understand the clinical procedures for managing these membranes.

The clinical effectiveness of ePTFE membranes is dependent upon surgical placement technique and maintenance of tissue coverage over the membrane. Preservation of the keratinized gingiva and a relatively thick overlying surgical flap are critical in order to avoid perforation of the flap by the membrane during healing. After the surgical area has been flapped, the defect is degranulated and the root surface is scaled and root planed. The ePTFE membrane is trimmed to adapt to tooth configuration, secured by ePTFE sutures, and the flap is repositioned. After membrane placement, healing is allowed to proceed for four to six weeks. Barring any membrane exposure, a second surgery is performed to remove the membrane. Radiographic evidence of bone fill is usually present after six months and should continue over the course of one year (**Figure 1**). Clinical studies have shown that ePTFE membranes used in guided tissue regeneration procedures are more effective than surgical debridement in correcting defects.[5-11] In furcations defects, there are gains in clinical attachment level (3 mm to 6 mm), improved bone levels (2.4 mm to 4.8 mm), and probing depth reductions (3.5 mm to 6 mm). Studies have demonstrated that these regenerative results can be maintained over the course of several years.[12,13]

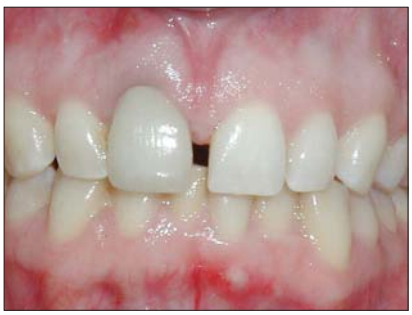
The major problem with nonresorbable membranes is the fact that the membrane is not tissue compatible and often becomes exposed to the oral environment during healing. Upon exposure, the membrane is contaminated and colonized by oral microflora.[14-17] Several studies have shown that contamination of the surgical field can result in decreased formation of new attachment.[18-22] If the membrane becomes exposed, the infection can be temporarily managed with a topical application of chlorhexidine.

This complication has led to the development and more popular use of bioabsorbable membranes. There are basically three types of bioabsorbable membranes: 1) polyglycoside synthetic polymers (i.e., polylactic acid, polylactate/polygalactate co-polymers); 2) collagen; and 3) calcium sulfate.

Several features make these bioabsorbable membranes easier to manage clinically: 1) they are more tissue compatible than nonresorbable membranes; 2) the timing for bioabsorption can be regulated; and 3) a second surgical procedure is not required to retrieve the nonresorbable membrane. Recent guided tissue regeneration studies comparing the use of bioabsorbable membranes with ePTFE membranes indicated that both membranes were equally effective.[21,22] This has resulted in most clinicians utilizing bioabsorbable membranes in guided tissue regeneration procedures.

Guided Tissue Regeneration for Periodontal Regeneration

The use of guided tissue regeneration in conjunction with various other regenerative approaches has been attempted with reported success. In a large case series using guided tissue regeneration in combination with root conditioning and demineralized freeze dried bone allograft, significant gains in clinical attachment level were observed in a variety of furcation and infrabony defects.[23] A subsequent study confirmed that the regenerated results were stable over five years.[24] When this combination was studied histologically, the amount of newly regenerated attachment varied from 0 to 1.7 mm.[25] A split-mouth, paired control study comparing guided tissue regeneration and guided tissue regeneration with DFDBA found that both groups had improved bone fill, but there were no statistically sig-



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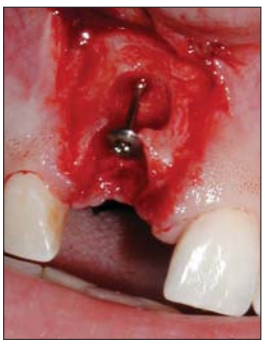

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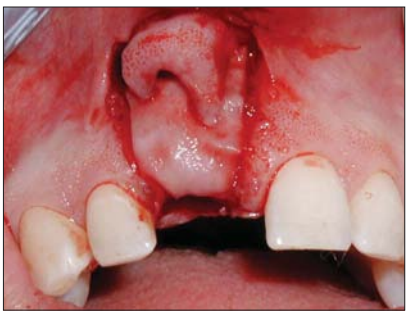

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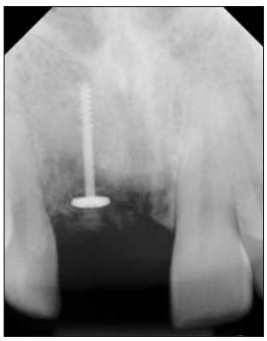

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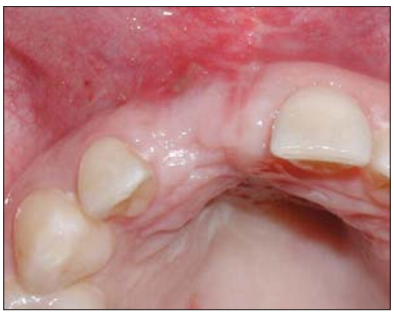

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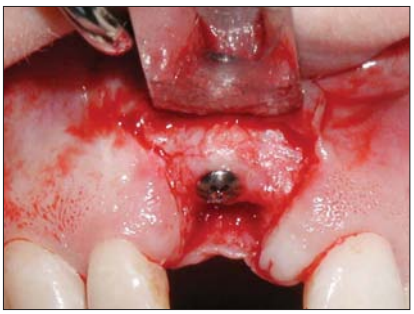

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Figure 2. Tooth No. 8 has 8 mm pocket depth on the labial with a probable root fracture (a). Following extraction, extensive loss of the buccal plate is present. A 10 mm bone screw was placed (b). The defect was filled with human bone allograft and covered with a resorbable membrane (c). Without the mechanical barrier effect of the guided bone regeneration membrane and the supporting tenting screw, replacement would not be possible. After four months, radiograph is suggestive of bone fill (d), and the horizontal (e) and vertical (f) deficiencies were corrected adequately for the placement of a dental implant (f).

nificant differences between the two groups.[26,27] These studies suggest that guided tissue regeneration techniques may be improved with the use of DFDBA as a defect filler, but controlled studies do not show any statistical differences.[27]

Guided tissue regeneration with bone grafting has been recently applied with the use of calcium sulfate. Calcium sulfate has been safely used in periodontics for the last four decades.[28-36] Animal studies indicate that calcium sulfate can create a "sealing" effect that permits the orderly replacement of bone in osseous defects. The calcium sulfate resorption time averages two to four weeks.[30] Early application of calcium sulfate to periodontal defects yielded favorable results, but did not demonstrate any capacity for osteoinduction.[32,33] Since the barrier effect was minimal, this technique was abandoned until its revival this past decade. Sottosanti was able to gain adequate time for regeneration by modifying the use of calcium sulfate to include bone grafts.[34]

This technique involves two basic components. The first is a composite graft of approximately 80 percent DFDBA and 20 percent calcium sulfate, which is placed into the defect. Over this composite graft, a second calcium sulfate barrier is placed. The advantage of this technique is that the materials are highly tissue compatible; it permits the management of large, irregularly shaped defects; it is infection resistant; and gaps in flap coverage do not appear to be significant. Several clinical case reports and series have suggested this as a viable technique, but there are no large clinical, controlled, or comparable studies to date which support its use.[34-36]

Guided Bone Regeneration for Implant Site Preparation

The principle of selective cell repopulation has been useful in preparing the implant placement site. Using a barrier membrane at an extraction site or a deficient alveolar ridge has been found to enhance bone formation. At the time of tooth extraction, the socket can be augmented with or without graft material and "sealed" with a barrier material. This procedure is called ridge preservation. Similarly, an alveolar ridge with a volumetric deficiency can be improved with the use of graft material and a barrier. This procedure is termed guided bone regeneration. Both of these approaches utilize the barrier concept to selectively permit osteoprogenitor cells to colonize the site so that an increased volume of bone may be formed.

In ridge preservation, the need for a

barrier membrane/material is highly dependent on the nature of the alveolar housing. In a thick gingival case with a thick labial alveolar plate, ridge preservation can be accomplished simply with atraumatic extraction. Alternatively, a thin gingival case with a thin labial plate is susceptible to remodeling. As the ridge heals, there is a tendency for the ridge to remodel apically as well as lingually, resulting in a vertical and a horizontal deficiency. To prevent this, ridge preservation procedures can be used to minimize atrophy in thin gingival cases, especially in the vertical dimension. This is especially important since most ridge augmentation techniques are fairly predictable in correcting horizontal defects, but are limited in the vertical dimension. Utilizing ridge preservation procedures preserve the bone and minimize bone resorption. This reduces the number of subsequent augmentation procedures needed. A modification of this technique is to utilize "tenting screws" to increase the vertical height and support the barrier membrane (**Figure 2**). This takes advantage of the highly osteogenic potential of the site to positively develop an additional 2 mm of vertical bone height.

In ridge augmentation, the deficient alveolar site is surgically exposed, degranulated, and the cortical plates are perforated. Graft materials are used as volumetric scaffolds and a membrane is used to seal the area. Titanium-reinforced ePTFE has helped maintain the space targeted for regeneration. However, the stiffness and thickness of ePTFE membranes often result in tissue perforation and the ensuing infection can compromise the amount of regeneration achievable. Recently, more tissue-compatible bioabsorbable membranes have become available. Regardless of the type of membrane used, employing guided bone regeneration for ridge augmentation is unpredictable, technique sensitive, and can generate bone volume mainly in the horizontal dimension.

New Approaches to Tissue Engineering for Periodontal Regeneration

During the last decade, tissue engineering research has focused on two main approaches involving the use of biological mediators to selectively enhance cellular repopulation of the periodontal wound. The first approach uses peptide sequences, protein preparations, and growth factors to regenerate tissues through the principle of biomimicry. Biomimetics is the science of constructing or mimicking natural processes or tissues, with the expectation that regeneration will proceed spontaneously. Enamel matrix derivative, platelet-rich plasma preparation-fibrin glue, and growth factors such as platelet-derived growth factor, purportedly function in this fashion. Enamel matrix derivative and platelet-rich plasma are currently being used with the recombinant platelet-derived growth factor, recently approved by the Food and Drug Administration for clinical use.

Bone morphogenetic protein is presently FDA-approved for limited orthopedic use, and its use in oral plastic surgery procedures is still under study.

The second approach uses growth differentiation factors to enhance periodontal regeneration. Bone morphogenetic proteins are differentiation factors that have been studied extensively for periodontal and bone regeneration. Bone morphogenetic protein is presently FDA-approved for limited orthopedic use, and its use in oral plastic surgery procedures is still under study.

Enamel Matrix Derivative

Enamel matrix derivative harvested from developing porcine teeth has recently been reported to induce periodontal regeneration. The rationale for the mechanism of action is that the enamel matrix derivative contains a mixture of low molecular weight proteins. When applied to root surfaces, the proteins are absorbed into the hydroxyapatite and collagen fibers of the root surface, where it induces cementum formation followed by periodontal regeneration.

In a multicenter study, 33 patients with at least two defects were treated in a split-mouth design. The experimental site was treated with acid etching and enamel matrix derivative while the control site was treated with a placebo.[37] Patients were examined at 8, 16, and 36 months after surgery. Increased bone fill of the osseous defect was observed over time for 25 of the 27 (93 percent) enamel matrix derivative-treated teeth, but no bone fill was detected in the controls. The mean radiographic bone fill was greater for the enamel matrix derivative-treated defects compared to the control sites (2.7 mm versus 0.7 mm). Statistically significant improvements were observed for enamel matrix derivative-treated sites over control sites in mean pocket reduction (3.1 mm versus 2.3 mm) and mean attachment level gain (2.2 mm versus 1.7 mm), respectively. These clinical findings have been supported by three recent studies.[38-40]

The histological finding of enamel matrix derivative-induced periodontal regeneration has been confirmed in a clinical case report.[41] A mandibular lateral incisor destined for orthodontic extraction was treated with acid etching

and enamel matrix derivative. After four months, the tooth was extracted and examined histologically. Regenerated cementum covered 73 percent of the defect and regenerated alveolar bone covered 65 percent. This histological finding has recently been confirmed in another case series.[42,43]

Although there are many clinical successes with this treatment, as with all graft materials, the results are inconsistent. Since enamel matrix derivative is purified and prepared like other bone graft materials (e.g., DFDBA, FDBA), its regenerative potential may vary from batch to batch. Characteristics that contribute to the variation in regenerative capacity need to be elucidated.

Growth Factors for Biomimicry

Growth factors are naturally occurring proteins that regulate various aspects of cell growth and development.[44,45] Recently, several growth factors have been identified and characterized, and some of them are found in the bone matrix. During wound healing, these growth factors modulate cell proliferation, migration, extracellular matrix formation, and other cellular functions. Additionally, some growth factors may also function as cell differentiation factors. In periodontal regeneration, much of the focus has been on platelet-derived growth factor and plasma-rich preparation.

Most of our information about growth factors comes from cell culture experiments. Prior to biotechnology, crude preparations of growth factors were applied to various cells in culture, and their effects on selected target cell types (i.e., fibroblasts, osteoblasts, epithelial cells), cell proliferation and function, extracellular matrix formation, and phenotypic expression were studied. Platelet-derived growth factor is one of the early growth factors studied for its effect on wound healing because it is a potent mitogenic and chemotactic factor for mesenchymal cells in cell culture. Utilizing the information from these cell biology experiments, platelet-derived growth factor and insulin-like growth factor-1 (IGF-1) were topically applied to periodontally diseased root surfaces in beagle dogs.[46,47] Substantial amounts of new bone, cementum, and periodontal ligament were present after two weeks. The results of this study were subsequently confirmed in three other studies utilizing beagles and experimentally induced periodontitis in nonhuman primates.[48-50] A human clinical trial was conducted using recombinant human platelet-derived growth factor/recombinant human IGF-1 (rhPDGF/rhIGF-1).[51] Utilizing a split-mouth design, defects were treated with either a low dose (50 µg/ml) or high dose (150 µg/ml) of rhPDGF/rhIGF-1. After nine months, high dose rhPDGF/rhIGF-1 induced 2.08 mm of new bone with 43.2 percent osseous defect fill, as compared to 0.75 mm vertical bone height and 18.5 percent bone fill in control. Low dose rhPDGF/rhIGF-1 was statistically similar to the control.

The unique advantage of rhPDGF-TCP will be its consistency in its regenerative capacity.

Simultaneously with the human clinical trial, a primate study examined the regenerative effects of PDGF/IGF-1 individually and in combination.[50] Platelet-derived growth factor alone was found to be as effective as the PDGF/IGF-1 combination in producing new attachment after three months. No significant effect was found when IGF was used alone. This study suggests that IGF may not be important at the dose level tested.

Recently, a multicenter clinical trial of rhPDGF was been completed and FDA approval obtained. Commercial availability of rhPDGF in combination with tricalcium phosphate (TCP) carrier is anticipated in the spring of 2005. One of the authors participated in the FDA's Phase 3 multicenter trial. The rhPDGF-TCP was found to be easy to use, required no barrier membranes, was more consistently reliable as a regenerative material, and had results comparable or superior to other regenerative graft materials. Histologically, periodontal regeneration has been demonstrated.[52,53] Details of the multicenter trial are forthcoming, but a sample clinical case is presented (**Figure 3**). The potential for using rhPDGF for regeneration of furcation defects and implant site preparation still needs to be evaluated.

The unique advantage of rhPDGF-TCP will be its consistency in its regenerative capacity. Unlike grafting materials and enamel matrix derivative, there is no variability due to purification or processing. The rhPDGF-TCP will provide a consistent dose necessary for regeneration. Variation in regenerative/healing response will be due to individual healing capability and surgical techniques. Whereas it is impossible to clinically control individual healing capability, surgical techniques and procedures can be developed. Further research is needed to define if guided tissue regeneration membranes will improve regenerative response, if root conditioning is necessary, and whether other surgical parameters will improve growth factor induced periodontal regeneration.

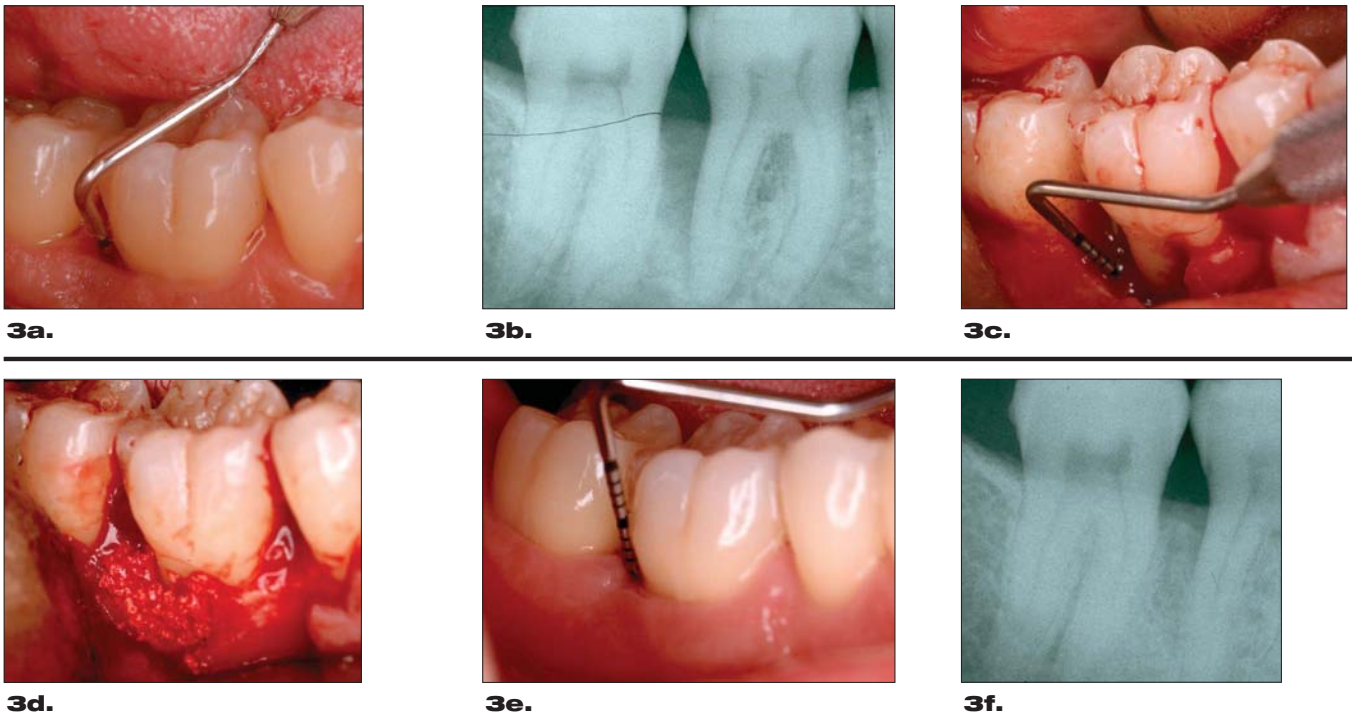

Figure 3. A 13 mm pocket depth was present on No. 30D (a) with radiographic bone loss to the apical quarter of the tooth (b). After flap curettage, the osseous defect was determined to be a 10 mm three-walled osseous defect (c). A soon-to-be commercially available rhPDGF-TCP mixture was used to fill the osseous defect (d). After six months, the pocket depth was 4 mm (e) and evidence of radiographic fill was present (f).

Platelet-Rich Plasma Preparation

The use of platelet-rich plasma preparation as a source of growth factors in bone and periodontal regeneration has been proposed.[54] In this approach, autologous blood is drawn and separated into three fractions: platelet-poor plasma (fibrin glue or adhesive), platelet-rich plasma, and red blood cells.

Platelets are enriched by 338 percent in the platelet-rich plasma preparation and concentrations of platelet-derived growth factor and TGF-ß in platelet-rich plasma preparation are 41.1 and 45.9 ng/ml, respectively.[55] Monoclonal antibodies have identified the presence of platelet-derived growth factor, IGF, and transforming growth factor-ß (TGF-ß) in the cytoplasmic granules of platelets. This preparation also contains a high concentration of fibrinogen. In clinical use, calcium and thrombin are added to the platelet-rich plasma preparation to activate the proteolytic cleavage of fibrinogen into fibrin. Fibrin formation initiates clot formation, which in turn initiates wound healing. Although many case reports attribute improved healing to these growth factors, it is questionable whether the concentrations used are adequate to elicit clinically measurable results. The level of platelet-derived growth factor is 3,000-fold less than the concentration needed for periodontal regeneration reported.[55] Alternatively, the accelerated healing may be the result of the presence of a fibrin clot, which stabilizes the early wound healing matrix. Platelet-rich plasma is in popular use to stabilize graft materials for implant site augmentation and appears to enhance early soft tissue healing.

Differentiation Factors — Bone Morphogenetic Proteins

Bone morphogenetic proteins are a group of regulatory glycoproteins which are members of the TGF-b superfamily. These molecules primarily stimulate differentiation of mesenchymal stem cells into chondroblasts and osteoblasts. At least seven bone morphogenetic proteins have been isolated from bovine and human sources. In the field of periodontal regeneration, much of the research interest has focused on BMP-2 (OP-2), BMP-3 (osteogenin), and BMP-7 (OP-1).[56]

The osteoinductive effect of bone morphogenetic proteins was characterized by using crude protein preparations derived from decalcified bone and has been extensively reviewed.[1-3] When these crude preparations were placed in muscle or subdermal pouches, an ectopic focal formation of cartilage was present

after 12 days and bone was present after 28 days. The induction of mesenchymal stem cell differentiation to recapitulate endochondral bone formation stimulated clinical interest in using bone preparations (FDBA and DFDBA) as osteogenic graft materials. However, when the actual concentration of bone morphogenetic proteins in commercial bone preparations was measured, the amount present was quite low. Approximately 10 kg of bovine bone yields 2 mg of bone morphogenetic proteins. This has resulted in efforts to purify, identify, characterize bone morphogenetic proteins so they can be synthetically produced by recombinant DNA technology.

Experiments utilizing crude and recombinant bone morphogenetic proteins have provided insight as to their potential use. Crude preparations of BMP-2 and BMP-3 applied in surgically induced furcation defects appeared to stimulate periodontal regeneration.[58] Studies have utilized recombinant human bone morphogenetic proteins to determine their potential for correcting intrabony, supra-alveolar, furcation, and fenestration defects.[58-61]

When recombinant human BMP-2 (rhBMP-2) was used in supra-alveolar periodontal defects, the gains in bone and cementum were 3.5 mm and 1.6 mm, respectively, compared to 0.8 mm and 0.4 mm for controls.[61] Histologic analysis revealed areas of periodontal regeneration associated with areas of ankylosis. Contrary to these findings, BMP-7 augmentation resulted in a significant increase in periodontal regeneration without any ankylosis. Healing through ankylosis has been a concern so most of the recent research utilizing rhBMPs has involved implant site preparation.[62-66]

Factors That Influence Therapeutic Success

Factors that adversely affect periodontal regeneration were reviewed at the 1996 World Workshop in Periodontics and at the 1997 Second European Workshop on Periodontology.[1,2] A number of factors have been implicated or shown to adversely influence periodontal regenerative therapy. These include:

Poor plaque control/compliance. Therapeutic gains from periodontal surgery deteriorate with poor plaque control and inadequate postoperative recall compliance.[67-72] Progressive deterioration and a higher incidence of infection with putative periodontal pathogens (*P. gingivalis, P. intermedia*, and *A. actinomycetemcomitans*) were more prevalent in patients with poor plaque control and compliance as compared to those with excellent plaque control and maintenance.[73] Furcation repairs also respond similarly, with deterioration for patients with poor plaque control and compliance, and increased stability in patients exhibiting the converse behavior.[74] Motivating patients to remain highly enthusiastic about oral hygiene and compliant with periodontal maintenance is difficult, but extremely important.[75-77]

The critical question to be addressed is whether the involved tooth is strategically important in the final restorative plan.

Smoking. Smoking is a major risk factor for not only disease progression, but also for adverse therapeutic outcomes.[78-80] Not only has smoking been implicated as having a detrimental effect on periodontal wound healing following surgical procedures, but it has also been linked to impaired healing response to guided tissue regeneration procedures in both intrabony defects as well as furcation repairs.[81-84]

Tooth/defect factors. Therapeutic success is influence by the tooth's importance in the prosthetic rehabilitation, its endodontic status, and defect characteristics.

The critical question to be addressed is whether the involved tooth is strategically important in the final restorative plan.[85] If not, then the regenerative procedure may not be justified due to its technical difficulty and expense, potential post-surgical complications, and the challenges of obtaining excellent patient oral hygiene and compliance.

Once a tooth is deemed essential, it is important to assess its endodontic status. Frequently, chronic endo-periodontal defects have the same appearance as an advanced intrabony defect. Treating an endo-periodontal defect without first addressing the endodontic component will result in failure.[86,87] Characteristics of the defect, such as the overall defect depth, width, and walls, can influence clinical outcomes in response to regenerative surgery.[88-90] Studies have consistently shown that the increased depth of the defect is correlated with increased improvement in clinical attachment level and probing depth. Conversely, the increased width of the defect has been correlated with decreased bone fill and clinical healing response. Lastly, intrabony defects characterized by three- or three- and two-walled configurations will generally respond more positively to regenerative procedures. Despite early reports on the use of iliac and autologous grafts, current regenerative approaches have not been consistently successful in regenerating one- or zero-walled defects.

Surgical management. As with any surgical procedure, flap management and wound stability are important. In the regenerative management of intrabony defects, it is important to ascertain

prior to surgery whether there is sufficient keratinized tissue to allow complete tissue coverage of the defect.

Summary

Over the last three decades, the periodontal literature has been filled with reports related to periodontal regeneration. This therapeutic goal, although ideal, is difficult to achieve. A variety of graft materials and regenerative strategies are now available; however, they all have limitations. The surgical procedure can be technically demanding, and when success is achieved, the maintenance of positive results is highly dependent on patients' oral hygiene habits and compliance with periodontal maintenance. Despite all these difficulties, periodontal regeneration is a clinical possibility that can be offered to patients. The clinician must carefully evaluate the various regenerative and reparative approaches and decide which technique may result in the best clinical outcome. With the advent of new regenerative approaches, such as biological modifiers like enamel matrix derivative and growth factors, we must critically evaluate how they may improve our ability to regenerate periodontal defects.

Treatment planning in periodontics also has changed dramatically in the last

Clinical Decision Tree for Management of Advanced Periodontal Defects

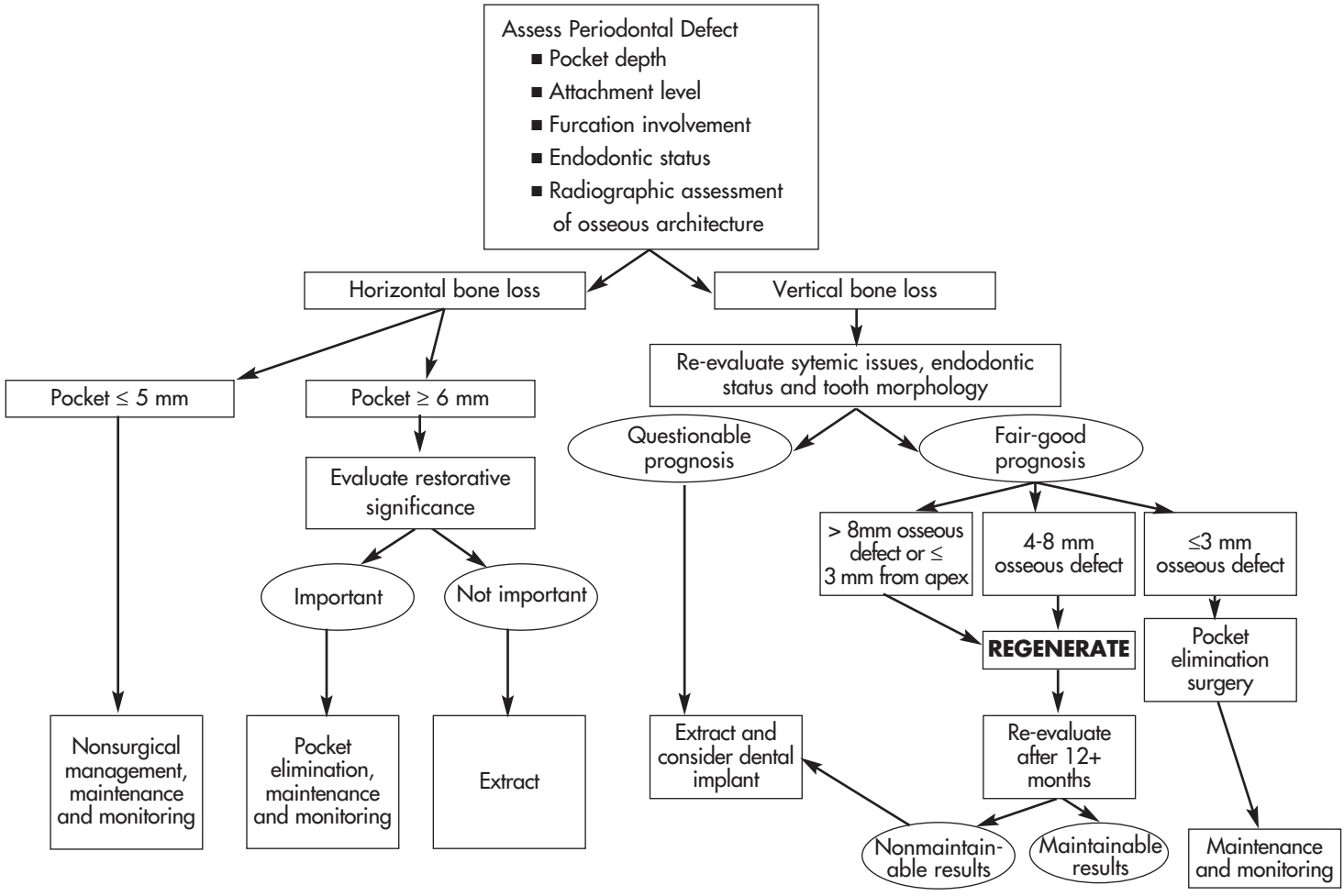

Figure 4.

decade because of the acceptance of dental implants as a viable long-term option for replacing missing teeth. With the increased predictability of implants, the question arises as to when to treat severe periodontal defects with regenerative procedures and when to perform strategic extraction in preparation for implant placement. Sometimes the best management of a periodontal defect may be extraction in lieu of periodontal regeneration or when regenerative efforts have been unsuccessful. Extraction would minimize further bone loss and provide the maximum volume of bone at the future implant healing site.

This paradigm shift has complicated our views about regeneration. With dental implants as a viable alternative, we need to redefine periodontal prognosis and consider strategic extraction more often. Conversely, heroic regenerative procedures would be contraindicated.

A clinical decision tree is provided to help guide the clinician in choosing regenerative procedures over other therapeutic approaches (**Figure 4**). As with any guidelines, there are exceptions to the rules. Clinicians are strongly advised to stay current with changes in the field of regeneration, as well as other aspects of periodontics and dental implants. The clinical decision tree may need to be modified to accommodate advances in these fields.

Periodontal regeneration continues to be one of the primary therapeutic approaches for the management of periodontal defects. Although evidence suggests that present regenerative techniques can lead to periodontal regeneration, the use of guided tissue regeneration and biological modifiers can enhance these results. The crucial challenge for the clinician is to critically assess whether a periodontal defect can be corrected with a regenerative approach, or whether it would be better managed with osseous resection for the slight periodontal defect and with strategic extraction for the advanced diseased state. CDA

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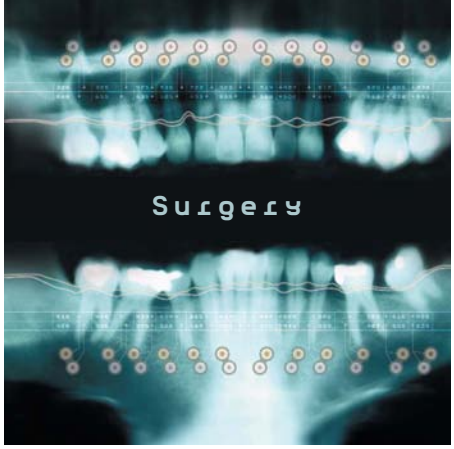

Periodontal Plastic Surgery as an Adjunctive Therapeutic Modality for Esthetic Restorative Dentistry

Kirk L. Pasquinelli, DDS

ABSTRACT

This paper summarizes the field of periodontal plastic surgery and its applicability as an adjunctive treatment modality in the delivery of esthetic restorative dentistry.

Esthetic dental problems are often multifactorial in nature and may not be satisfactorily resolved by restorative treatment alone. An interdisciplinary approach to these situations offers the greatest potential for an outstanding treatment result. The better versed the restorative dentist is in adjunctive therapeutic modalities available from the dental specialties, the greater will be their ability to deliver a superior result. Periodontal plastic surgery may be utilized in the interdisciplinary solution to many esthetic clinical challenges.[1]

Periodontal plastic surgery deals with the cosmetic reconstruction, reshaping, or removal of the dentoalveolar tissues.[2] The procedures common to the field include: root coverage, ridge augmentation, ridge preservation, preprosthetic ridge alteration, and esthetic crown lengthening. The ultimate goals of periodontal plastic surgery procedures are to provide the patient with their desired esthetic outcome while maintaining the health of the teeth and periodontium.

Through a series of case reports, the objective of this paper is to help restorative dentists further their knowledge of periodontal plastic surgery as it pertains to the planning and delivery of sound biologic dental therapy that optimizes esthetics.

Root Coverage

Root exposure resulting from apical recession of the marginal tissues may create esthetic concerns for a patient. As the length of the teeth increase, there is loss of gingival symmetry as well as increased sensitivity, susceptibility to caries, and concern over the retention of the teeth (**Figure 1a**). Restorative coverage of the root can reduce sensitivity or treat caries but cannot decrease the length of the clinical crown, restore the lost periodontal support, or prevent future recession by strengthening the periodontium.

The clinical goals of root coverage procedures are to replace the tissues lost due to recession, effect an attachment of the restored tissues to the root of the tooth, reduce thermal and touch sensitivity, prevent future recession, and improve the esthetics of the area.

In 1985, Raetzke and then Langer and Langer, described the use of connective tissue grafts for root coverage.[3,4] In this technique, palatal connective tissue is transplanted into an envelope-like pouch prepared at the recipient site

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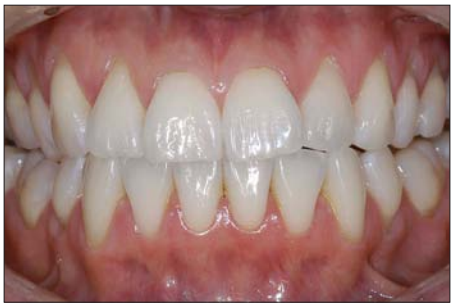

Figure 1a. Patient presents with generalized slight to moderate recession, gingival asymmetry, thin alveolar housing, and lack of attached gingival.

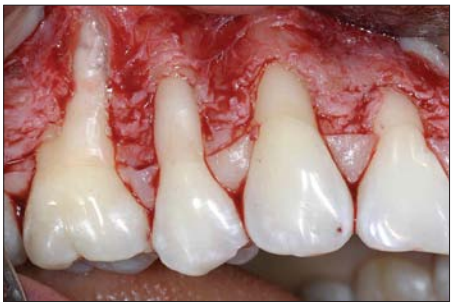

Figure 1b. Split-thickness recipient site preparation with primary flap elevated to create pouch for graft. The roots have been instrumented.

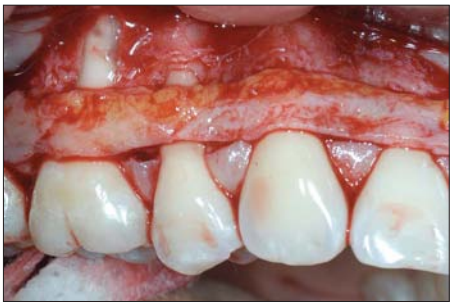

Figure 1c. Prior to closure of the primary flap a connective tissue graft is placed over the roots.

(**Figures 1b, c**). This pouch provides a dual blood supply to the graft from the superior and inferior connective tissue surfaces in contact with the graft. The retained superior flap also maintains the esthetics of the original tissues and acts as a source for the epithelial cells that migrate over the exposed portion of the connective tissue graft (**Figures 1d, e**). These grafts are very successful in covering the root and blending with the adjacent tissues for a highly esthetic result (**Figures 2a, b**).

Improved methods of surgical magnification, illumination, and instrumentation have increased the precision of these procedures. As a result, there is decreased trauma to the tissues allowing for improved outcomes and reduced patient discomfort.[5]

Ideally, these grafts would attach to the root versus forming a pocket created by the new tissue covering the facial of the root. Several authors have shown clinical measurements that are consistent with attachment of the grafted tissue to the previously exposed root surface, and histological case reports have shown new bone and connective tissue attachment on these root surfaces.[6-8]

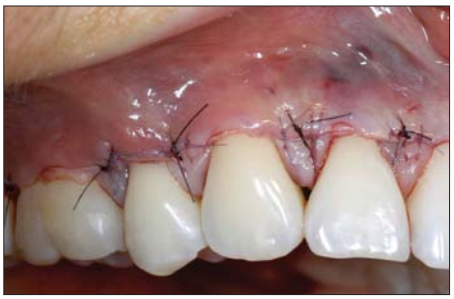

Figure 1d. Primary flap sutured closed over the connective tissue graft with 7-0 sutures.

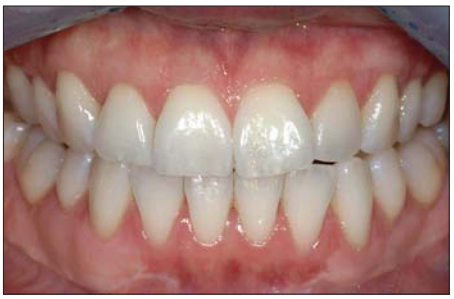

Figure 1e. Seven months' postop. The maxillary recession has been corrected, gingival symmetry has been restored, the gingival is thicker, and there is an increase in the amount of attached gingival. The mandibular teeth were simultaneously treated with free gingival grafts.

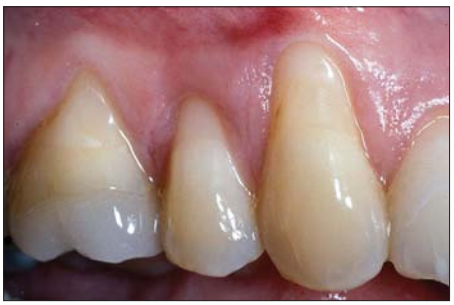

Figure 2a. Patient presents with moderately advanced recession and a lack of attached gingival.

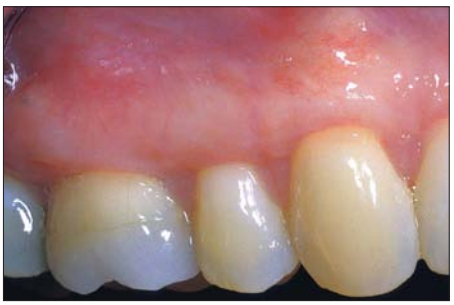

Figure 2b. Two months following a connective tissue graft. There is complete root coverage as well as an increase in the thickness and vertical dimension of the attached gingival. The grafted tissues blend well with the native tissue.

Ridge Augmentation and Preservation

Removal of a tooth or implant results in collapse of the alveolus and causes a shift of what had been the free gingival margin in an apical and lingual direction.[9,10]

Esthetic restoration of missing teeth with pontics or implants often will require reconstruction of this lost tissue prior to placement of the prosthesis. Ridge augmentation techniques have been developed that allow predictable replacement of alveolar tissue lost after the removal of teeth. Ridge preservation techniques, performed simultaneously with tooth or implant removal, can prevent the natural collapse of the ridge and will limit the loss of bone and soft tissue.

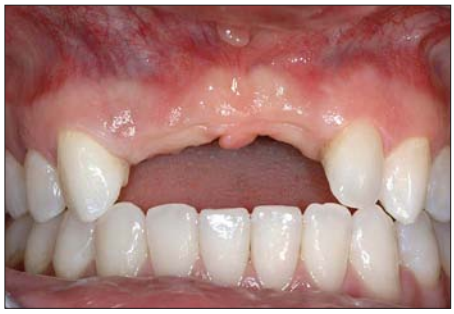

Figure 3a. Patient presents with moderate Class III ridge defect and a failing tooth No. 10 that will need to be removed. Implants are planned for the No. 7 and 10 sites.

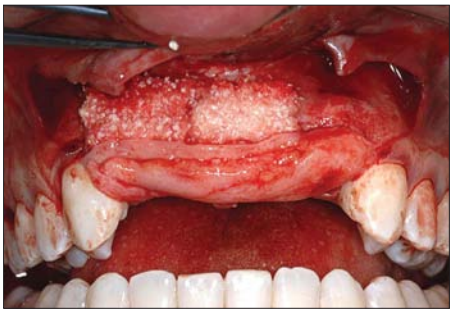

Figure 3b. Tooth No. 10 has been removed and implants placed in the No. 7 and 10 positions. The ridge has been augmented with a combination of bone grafting and laminated connective tissue grafts.

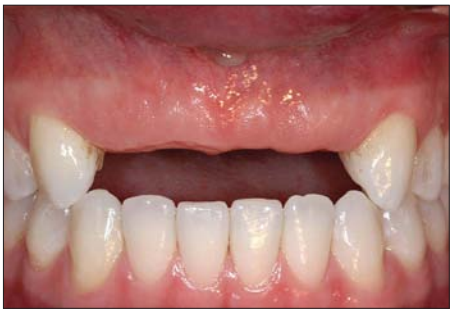

Figure 3c. Six-month postop. At this time, the ridge was assessed as adequate and the patient was referred to the restorative dentist to begin therapy.

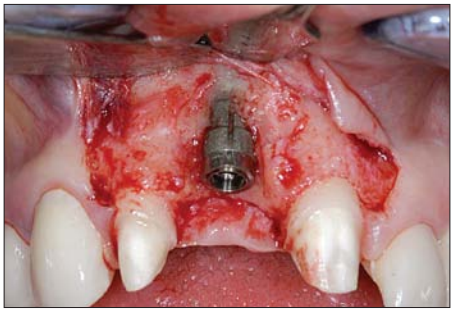

Figure 4a. Failing implant at the No. 8 position. The implant needs to be removed and the ridge reconstructed to prevent collapse.

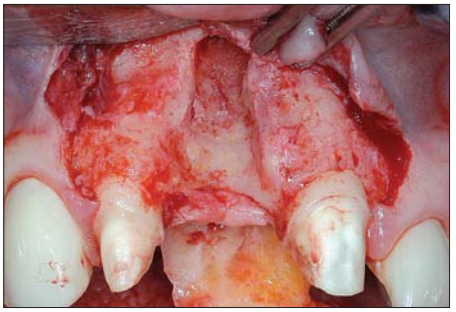

Figure 4b. After removal of the implant, there is substantial loss of the buccal plate. The mesial, distal, and palatal walls of the extraction socket are relatively intact.

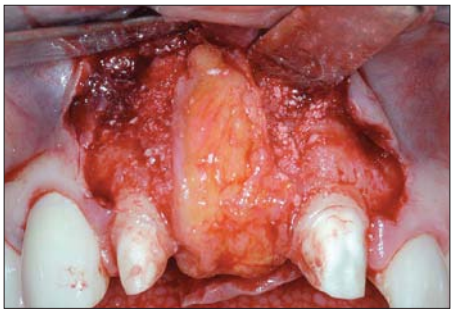

Figure 4c. A slowly resorbable bone graft material has been placed in the socket and covered by a connective tissue graft.

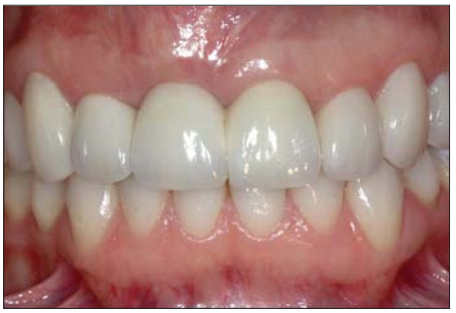

Figure 4d. A fixed partial denture with an ovate pontic at the No. 8 site was utilized to replace the failed implant (Restorative dentistry by Dr. Belinda Gregory-Head).

Ridge Augmentation

Collapsed ridges can be built up in a variety of ways: soft tissue grafts, bone grafts, guided bone regeneration, alveolar distraction osteogenesis, and combinations of these techniques (**Figures 3a-c**).[11-16] The anatomy of the defect, and the restorative plan, will aid in selection between these available techniques.

If a fixed partial denture is planned, connective tissue grafts can be used to restore the missing tissue volume. Large defects may require several layers of connective tissue to restore the missing tissue volume. In some cases, multiple, sequential, ridge augmentations will be required to fill the defect. The final prosthesis can be undertaken four or more months after the last surgical procedure.[1]

This technique can also be used to increase the volume of soft tissue around previously placed implants, and it can be helpful in the restoration of papillae adjacent to implants and pontics.

If implants are planned, the amount of bone in the site will determine the type and sequence of any grafting procedures. If there is a deficiency of bone large enough that primary stabilization of an implant is not possible, then the necessary bone volume should be restored first. Once adequate bone volume is established, the soft tissue is assessed for esthetic harmony and augmented as necessary.

Ridge Preservation

Ridge preservation procedures are combined soft tissue and hard tissue grafts of extraction sites done in conjunction with the removal of teeth or implants (**Figures 4a-d**). The purpose of these procedures is to prevent resorption and collapse of the ridge, thereby reducing the need for subsequent augmentation of a deficient ridge.

Extraction should be done as atraumatically as possible in order to pre-

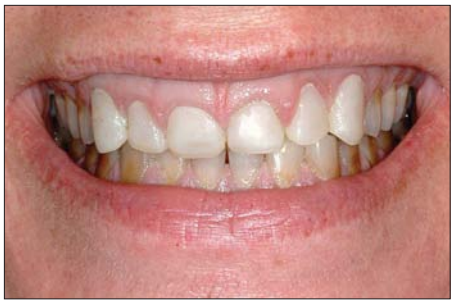

Figure 5a. Patient presents with an asymmetric free gingival margin position, excessive gingival display, failing restorations, and tetracycline staining.

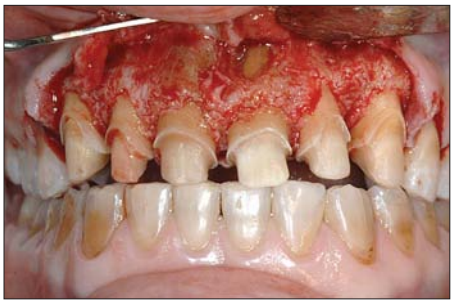

Figure 5b. Flap elevated to show the position of the osseous crest. Bone will need to be removed circumferentially around each tooth to establish adequate room for the dentogingival complex apical to the desired position of the crown margins. Note the apical loss of the buccal plate due to an endodontic lesion on tooth No. 9.

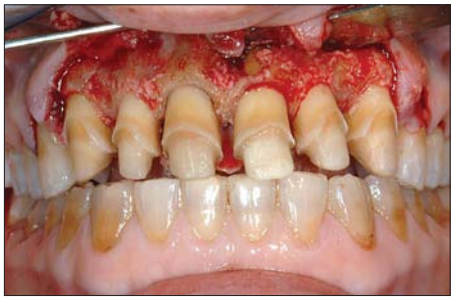

Figure 5c. Osseous surgery has been done to remove enough bone to re-establish the position of the dentogingival complex relative to the projected restorative margins. The lesion on No. 9 was treated with endodontic therapy.

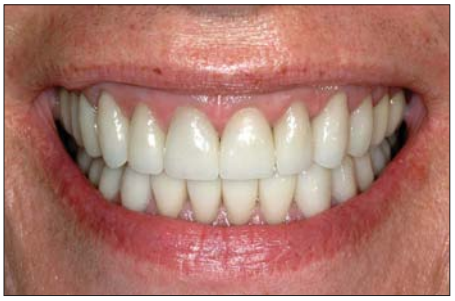

Figure 5d. Post-treatment smile exhibiting gingival symmetry, reduced gingival display, and improved dental esthetics (Restorative dentistry by Drs. Julie Djie and Dan Gustavson).

serve as much of the supporting bone and gingival tissues as possible. An osseous graft is then placed in the socket and covered with a connective tissue graft, tissue plug, or barrier membrane.[17-19] At the completion of the procedure, a provisional restoration is placed. Four months later, the tissues are assessed. If there is no need for further augmentation, the final prosthesis is begun.

Crown Lengthening

Patients may present with an excessive or aberrant display of gingival tissues (**Figure 5a**). Periodontal crown lengthening procedures can modify the supporting apparatus of the teeth through the judicious surgical removal and reshaping of the soft tissues and/or bone. The desired result is an increase in the length of the clinical crown and a concomitant reduction of gingival exposure. This will effect an improvement in esthetics by altering the ratio of the clinical crown to the marginal tissue in favor of the teeth.

Successful crown lengthening requires an understanding of the biologic width of attachment, the dentogingival complex, and the relationship among the alveolar crest, the position of the free gingival margin, and the tip of the papilla.[20-22] The goal of crown lengthening surgery is to reposition the dentogingival complex to a location on the tooth that is esthetically and structurally more favorable while maintaining the health of the tissues.

Periodontal crown lengthening can be accomplished in several ways: gingivectomy, apically positioned flaps, osseous surgery, or a combination of these techniques. The most frequently utilized method, osseous surgery, is used when it is necessary to remove bone to establish the necessary 3 mm between the alveolar crest and the desired position of the free gingival margin (**Figures 5b, c**). This 3 mm is the distance required for the dentogingival complex. Poor results will be produced if a gingivectomy is used as the sole method of crown lengthening in a situation that requires the removal of bone to make room for the dentogingival complex. When the bone is not removed, the soft tissues will rebound postoperatively to re-establish the dimensions of the dentogingival complex and the final free gingival margin position will be too far coronal on the tooth.

If an intracrevicular margin is planned, the restorative dentist needs to wait until maturation of the attachment and stability of the gingival crevice prior to the final restoration of the case[23] (**Figure 5d**). The time to stable tissue maturity varies between patients and procedures. Postoperative tissue stability can be ensured by two similar measurements of sulcus depth and free gingival margin position over time. The interval between these measurements should be at least six weeks.

Summary

This paper summarizes the field of periodontal plastic surgery and its applicability as an adjunctive treatment modality in the delivery of esthetic restorative dentistry. CDA

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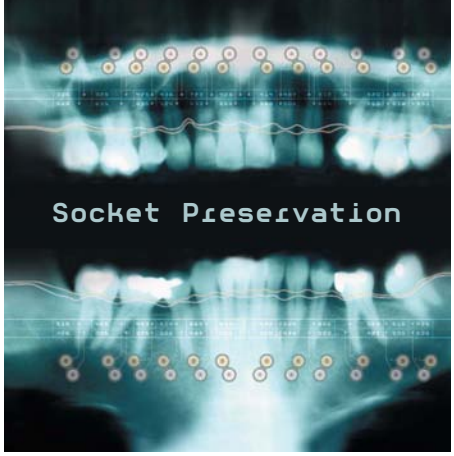

Alveolar Ridge Preservation at Tooth Extraction

Gordon L. Douglass, DDS

ABSTRACT

The principles of guided bone regeneration, which are at the core of contemporary periodontal therapy, have evolved into the present generation of barrier membranes, which greatly improve the overall result by not requiring primary closure. The supplemental addition of calcium sulfate to the graft materials appears to accelerate the rate of vital bone formation. In the future, these procedures are likely to become less invasive and more predictable, barrier membranes may not be needed and additional materials will be available that will accelerate the formation of bone.

The extraction of teeth results in resorption of the alveolar ridge.[1-3] Resorption occurs primarily on the buccal side of the ridge with ridge width most affected, but ridge height also diminished. Today, it is possible to reduce the loss of alveolar ridge height and width to a minimum by preserving the bone volume at the time of extraction. This provides for a better site for the placement of dental implants with greater implant to bone contact by allowing the placement of longer, wider implants and improved esthetics of the final restoration with better emergence profiles and gingival architecture. A recent systematic review by Fiornelli and Nevins found that implants placed in augmented edentulous sites had a survival rate similar to implants placed in native bone.[4]

Currently, the preservation of extraction sockets is based on the principles of guided bone regeneration which have been used successfully in periodontics since 1982.[5] Guided bone regeneration techniques for socket preservation consist of a barrier membrane over a bone graft in the socket. Many investigators have found that grafts placed with barrier membranes have a lower amount of bone resorption because the membrane prevents the in growth of connective tissue and a loss of graft volume.[6-8] A variety of techniques have been utilized, using nonresorbable and resorbable barrier membranes, autogenous or allogenic bone grafts, and xenografts.

The early techniques developed by Buser and Dahlem used an expanded polytetrafluoroethylene membrane.[9,10] While this technique was very successful and is still utilized today for the augmentation of edentulous ridges, it required primary closure, which altered the mucogingival junction, and a second procedure to remove the membrane (**Figures 1a-f**). Today, the techniques have evolved with the use of membranes that do not require primary closure, and surgical techniques that are less invasive, both of which may improve the retention of optimal gingival form (**Figures 2a-f; Figures 3a-g**).[11]

The normal healing of untreated extraction sockets results in fill of the socket area with vital bone, but generally with a significant loss of bone ridge volume. The placement of an autograft, xenograft, or allograft results in some retention of nonvital graft material for a period of time. The placement of the graft increases the alveolar ridge volume but may slow the formation of new vital bone.[12] Studies have reported 5 percent to 35 percent residual graft materials and from 30 percent to 60 percent vital

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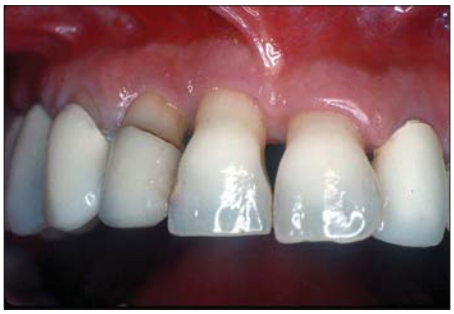

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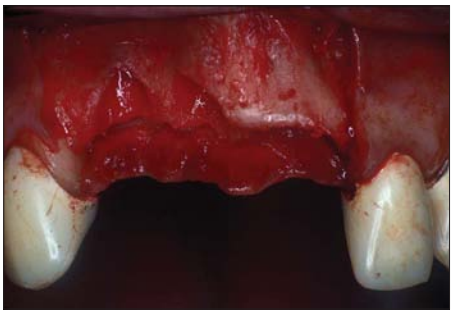

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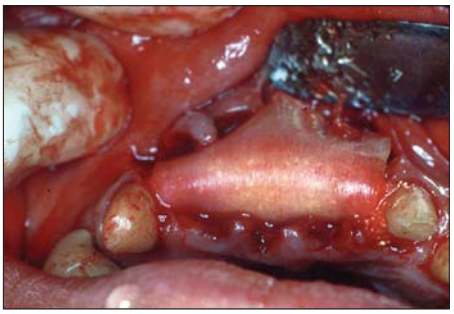

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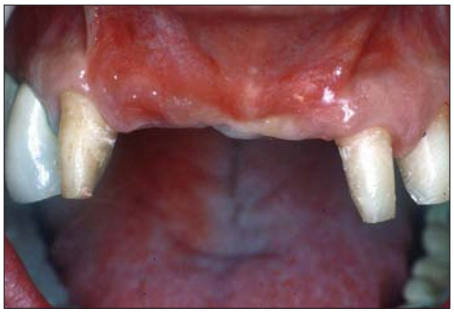

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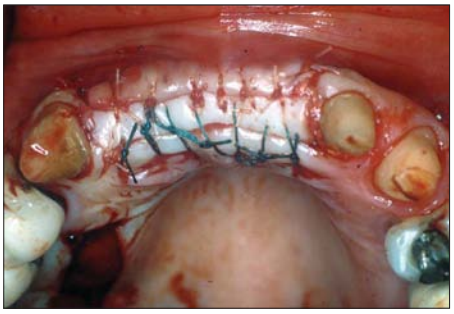

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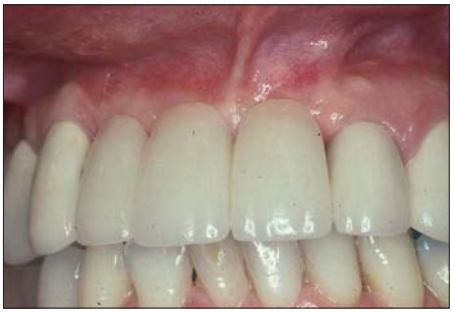
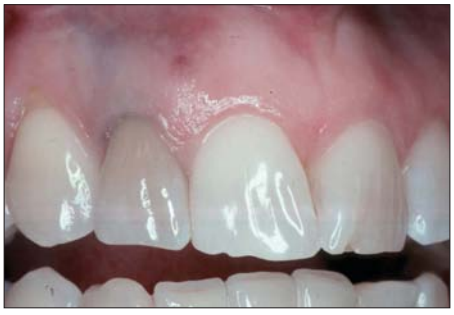


Figure 1f.

Figure 1. Clinical photographs of the extraction of three maxillary anterior teeth and placement of a membrane that required primary closure (a,b,c). The loss of buccal keratinized gingiva from primary closure (d). Gingival grafting to re-establish adequate buccal gingiva (e). The final restoration (f).



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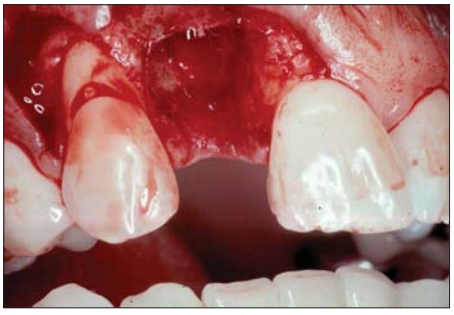

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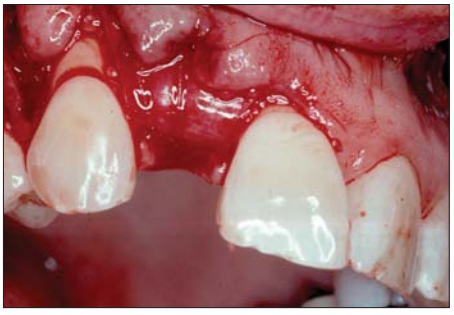

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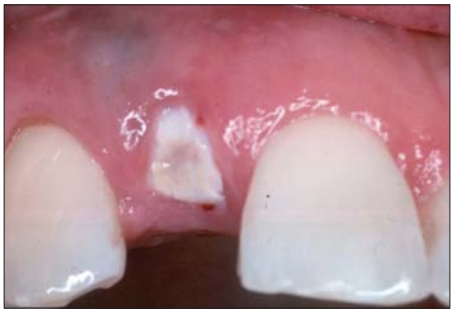

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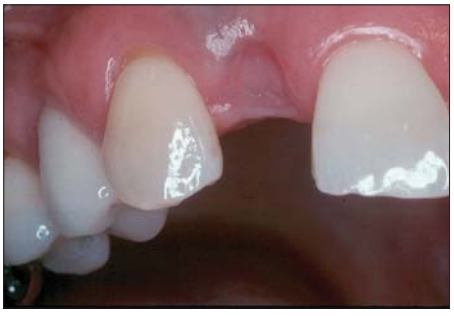

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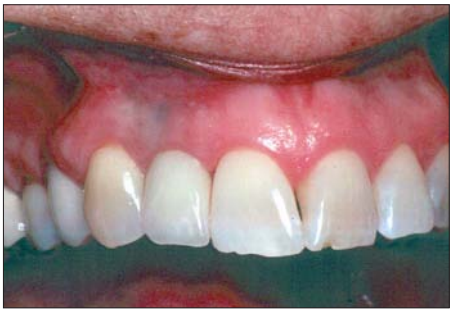
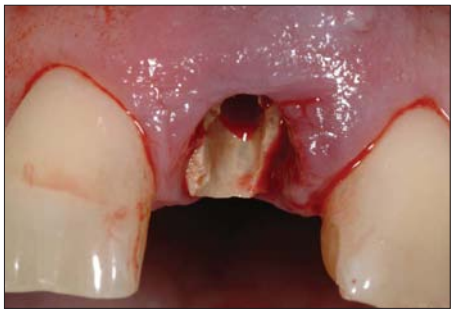


Figure 2f.

Figure 2. The extraction of a maxillary lateral incisor, the socket-protected membranes that did not require primary closure (a,b,c). The healing at four weeks around a TefGen membrane (d). The healed socket area at three months (e). The final implant restoration (f).



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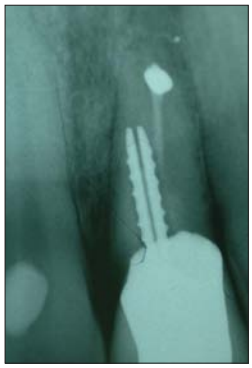

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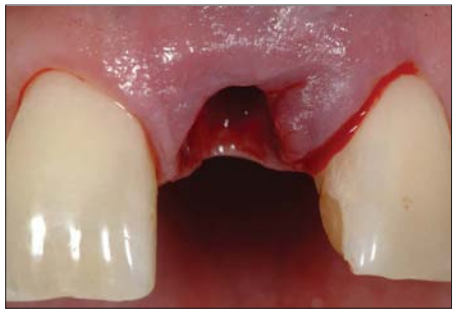

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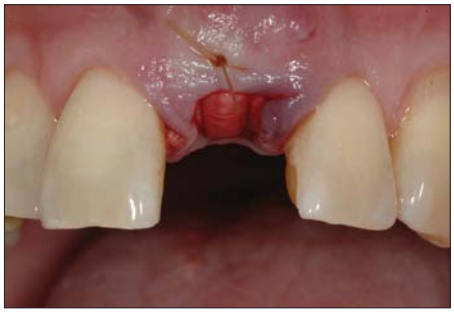

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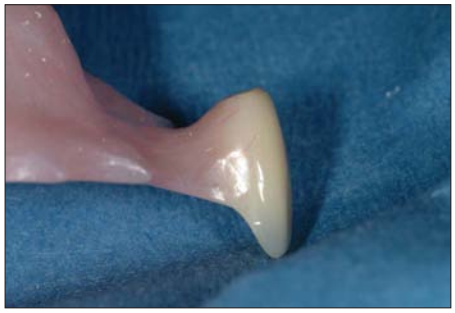

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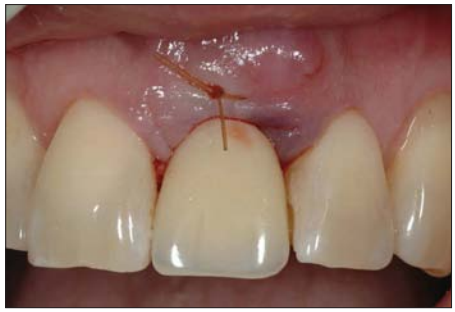

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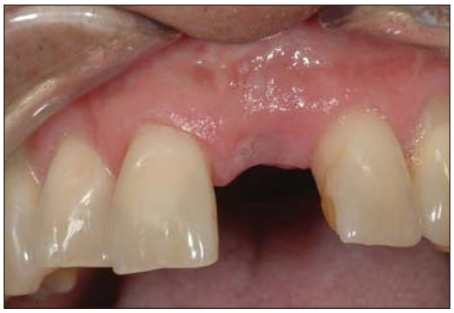


Figure 3g.

Figure 3. The extraction of a fractured maxillary central incisor without flap elevation (a,b,c). The grafted socket was covered with a Bio-Gide membrane (d). A conical-shaped pontic was placed over the socket (e,f). Healing at three months (g).

bone at varying time intervals, but with most being about four to six months.[13-16] The addition of surgical-grade calcium sulfate to autogenous grafts or to grafts with decalcified freeze-dried bone allograft has been shown to increase angiogenesis and improve clinical results.[17-20]

Vance and co-workers reported that the use of putty containing decalcified freeze-dried bone allograft and calcium sulfate with caboxymethylcellulose in a 50-50 ratio in extraction sockets was equivalent in volume to a bovine-derived hydroxyapatite xenograft and membrane. However, at four months the calcium sulfate and decalcified freeze-dried bone allograft combination demonstrated 61 percent vital bone compared to 26 percent vital bone for the xenograft.[21] This is consistent with the findings of Guarnieri et al. who found 58.6 percent vital bone in extraction sockets three months following grafting with medical-grade calcium sulfate hemihydrate.[20] Therefore, the addition of calcium sulfate to grafts may accelerate the rate and quantity of vital bone formation.

In almost all studies, buccal and lingual flaps are elevated to provide access for the extraction and/or placement of a membrane. The elevation of flaps is likely to affect the height of the interdental papillae. To avoid elevating, various flap designs have been devised.

The Effect of Flap Elevation on Papillae Height: A Case Series

To determine the effect that buccal and lingual flap elevation has on the papillary height, 35 single tooth extractions of maxillary anterior teeth with flap elevation were compared to 38 consecutive extractions of maxillary anterior teeth without flap elevation. The height of the mesial and distal papillae was measured from the incisal edge before extraction and at six weeks. The average loss of papillae height was 1.6 mm with flap reflection, but only 0.85 mm without flap reflection. Therefore, whenever it is possible to extract and augment the socket without elevating a flap in esthetic areas, that technique should be given consideration (**Figures 4a-d**).

Surgical Techniques for Extraction Socket Preservation

Flap Design

Whenever possible, the elevation of buccal and lingual flaps should be avoided in areas where esthetics is critical. If a flap is necessary, a flap only on the buccal aspect should be considered, retaining the papillae in the maxillary anterior area (**Figures 5a-d**). This may result in less loss of papillary height.

Tooth Extraction

Atraumatic extraction of a tooth requires patience and a gentle technique. Every attempt should be made to minimize trauma to the alveolus during the extraction. The initial incision is made with a microsurgical blade (Sable 610 microspear, Sable Industries, Oceanside, Calif.) which separates the supracrestal gingival fibers and begins the separation of the periodontal ligament. To preserve the buccal plate, the periodontal ligament fibers can be further separated with the use of a periotome avoiding the buccal plate. Frequently, the tooth can be extracted with only the use of a periotome, or if there is adequate tooth structure, the tooth can carefully be removed with extraction forceps. Small elevators can be used, but luxation should be in a mesiodistal direction. Tapered forceps should be considered which better adapt to the tooth than standard extraction forceps. If there is inadequate tooth structure and the tooth cannot be extracted with the periotome, then the tooth can be carefully sectioned so the remaining root fragments can be extracted without placing pressure on the alveolus. Once the tooth is extracted, the socket should be thoroughly debrided removing all visible granulation tissue and irrigated with normal saline. Removal of all the granulation tissue will improve the new bone formation in the socket.

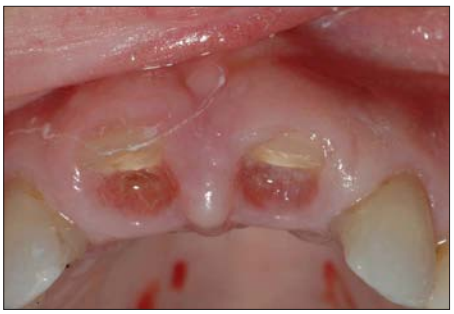


Figure 4a.

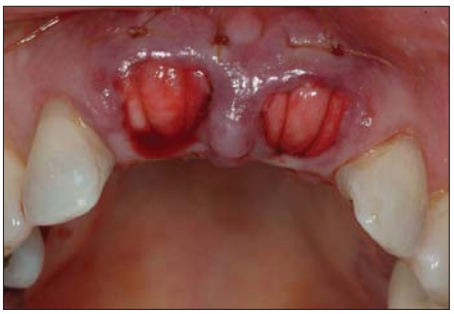


Figure 4b.

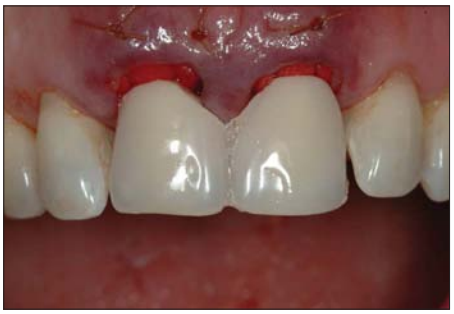


Figure 4c.

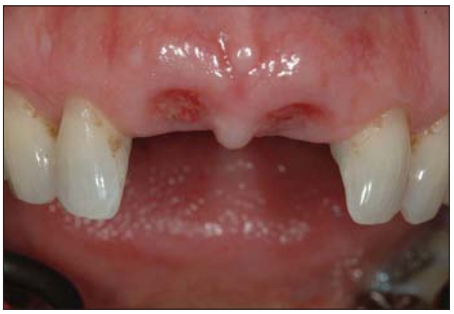


Figure 4d.

Figure 4. The extraction of both maxillary central incisors without flap elevation and socket coverage with a Bio-Gide membrane (a,b). Slightly conical pontics were placed (c). Healing at three months with maintenance of papillae height (d).

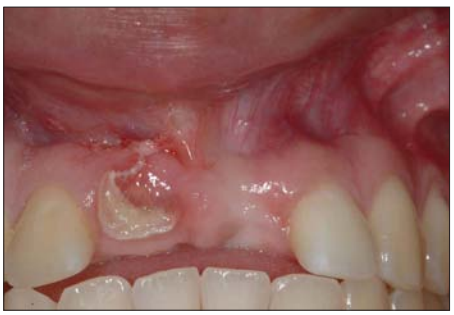
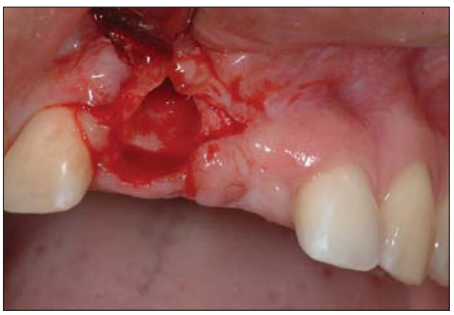


Figure 5a.



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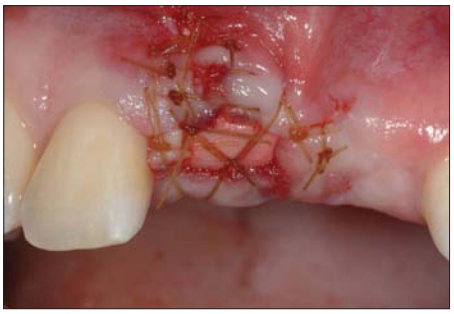


Figure 5c.

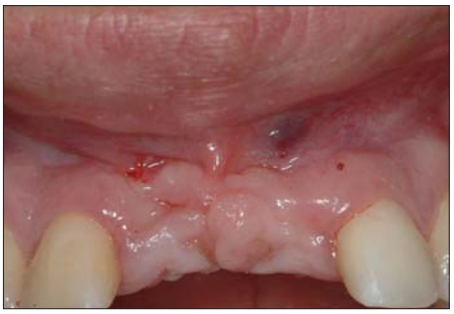


Figure 5d.

Figure 5. The extraction of a maxillary central incisor with flap elevation only on the buccal (a,b). The grafted socket covered with a Bio-Gide membrane (c). Healing at four months with maintenance of gingival height (d).

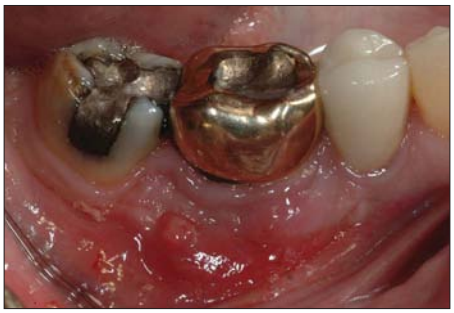


Figure 6a.

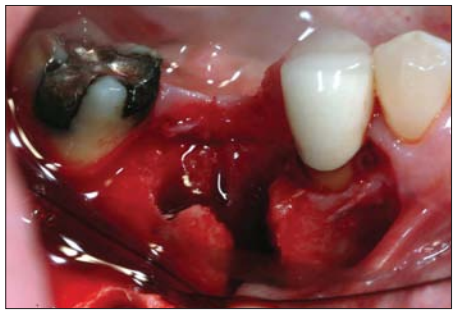
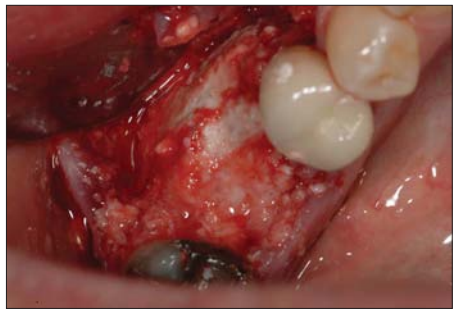


Figure 6b.



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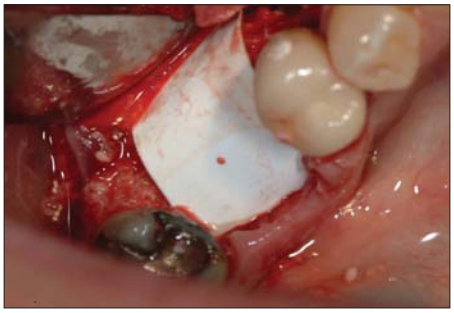

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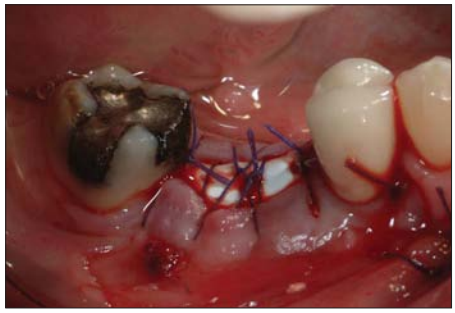

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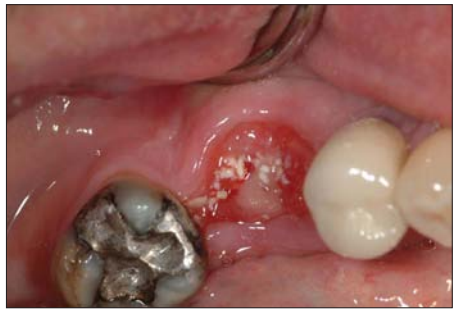

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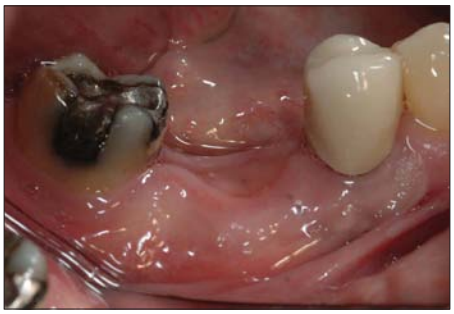


Figure 6g.

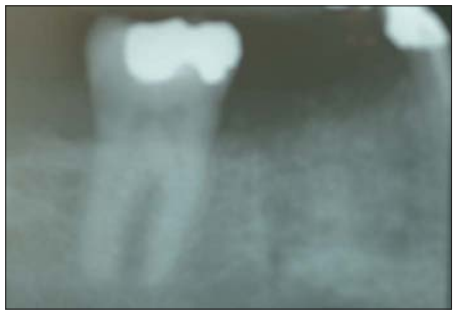


Figure 6h.

Figure 6. The extraction of a mandibular first molar with significant loss of the buccal plate (a,b). The socket grafted with decalcified freeze-dried bone allograft and calcium sulfate (c). The socket covered with a TefGen membrane that is left exposed (d,e). Healing at five weeks when the membrane is removed (f). Healing at three months (g,h).

Bone Graft Materials

The author prefers using decalcified freeze-dried bone allograft plus calcium sulfate (Calcigen, Implant Innovations, Palm Beach Gardens, Fla.) in most sockets to provide the most rapid turnover into vital bone. There continues be a growing number of studies showing a significant acceleration of the formation of vital bone with the addition of calcium sulfate to bone grafts.[22,23] However, many socket areas are so badly damaged that the graft needs to be more substantial and bovine-derived hydroxyapatite (BioOs, Osteohealth Co., Shirley, N.Y.) is added to the mixture. The addition of calcium sulfate (Calcigen) also improves the handling of the graft mixture facilitating placing it in the socket.

Barrier Membranes

Almost all barrier-membrane needs can be met by utilizing one of two membranes, dense PTFE (TefGen, Lifecore Biomedical, Chaska, Minn.) or resorbable collagen (Bio-Gide, Implant Innovations). While there are numerous collagen products on the market, all are not suitable for intentional exposure. The Bio-Gide product appears to survive well when intentionally left exposed. Both membranes can be exposed, therefore not requiring primary closure. The dense PTFE is best in large sockets (**Figures 6a-h**), particularly molar areas while the resorbable collagen is best in esthetic sites (**Figures 4a-d**). The dense PTFE should be removed at about five weeks. It is readily removed using cotton pliers without anesthesia. A combination of membranes can be used in badly damaged extraction sockets. For sockets with severe buccal plate defects, a relatively stiff resorbable collagen membrane (BioMend Extend, Zimmer Medical, Carlsbad, Calif.) can be placed on the buccal to assist with space maintenance (**Figures 7a-g**). However, in the author's experience, this membrane is not one that should intentionally be exposed, therefore, the socket can be covered with a Bio-Gide membrane.

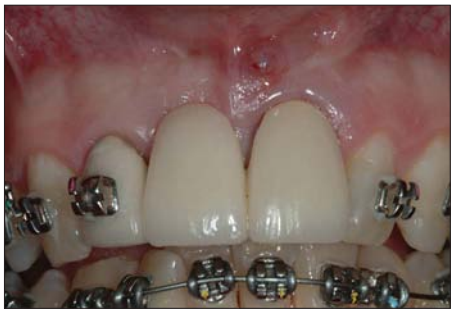
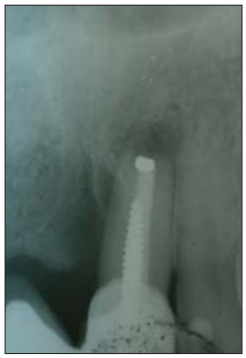


Figure 7a.



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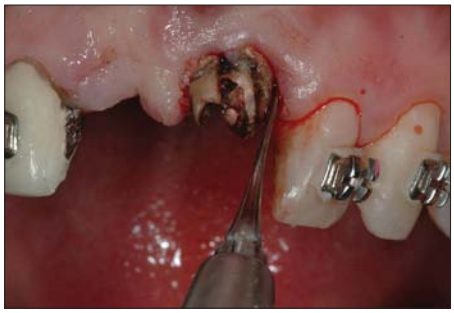


Figure 7c.

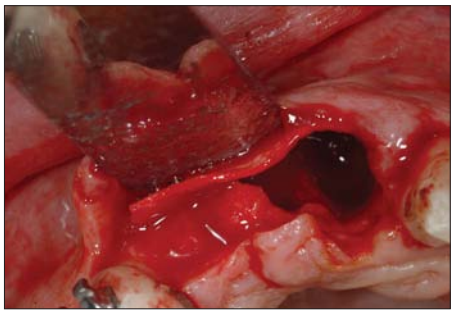


Figure 7d.

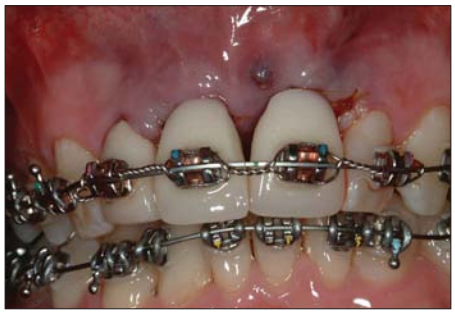


Figure 7e.

Figure 7f.

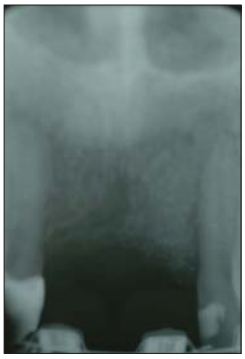


Figure 7g.

Figure 7. The extraction of a fractured maxillary central incisor with significant bone loss (a,b). The tooth is extracted with a periotome (c). The buccal plate is completely lost and restored with a BioMend membrane (d). The area sutured with the membrane exposed (e). Healing at three months (f,g).

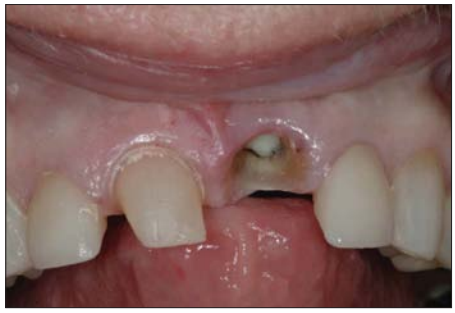


Figure 8a.

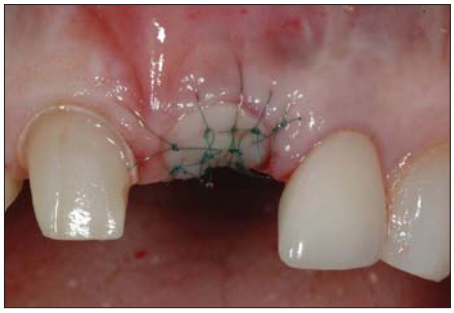
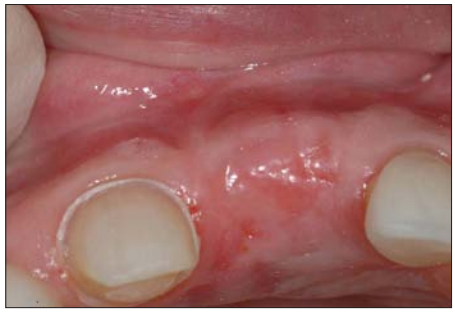


Figure 8b.



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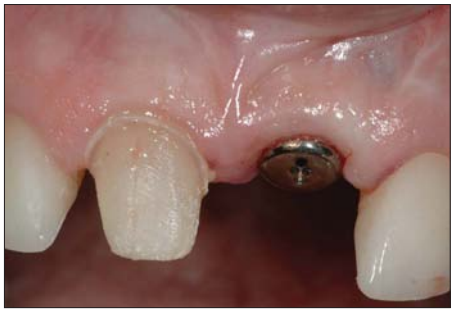


Figure 8d.

Figure 8. A fractured maxillary central incisor is extracted and the socket graft covered with a free gingival graft (a,b). Healing at six weeks (c). Increased buccal gingival with implant healing cap in place (d).

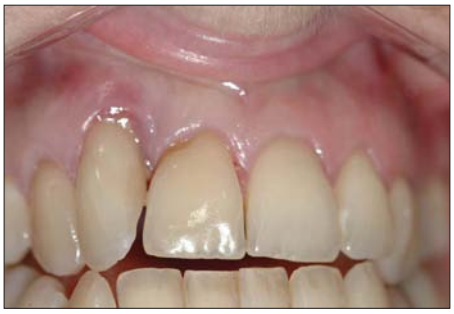


Figure 9a.

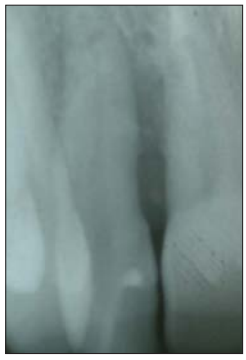
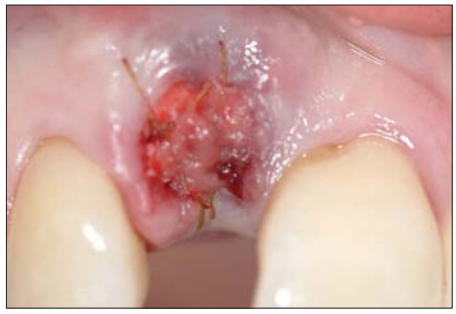


Figure 9b.



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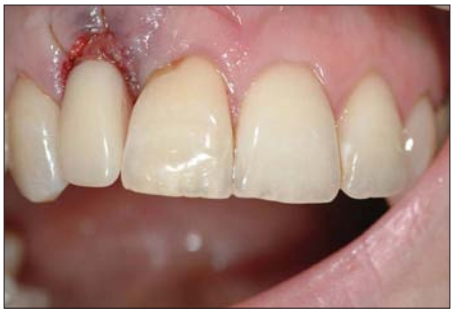

Figure 9d.

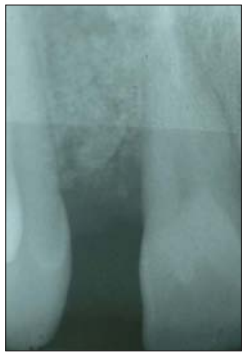

Figure 9e.

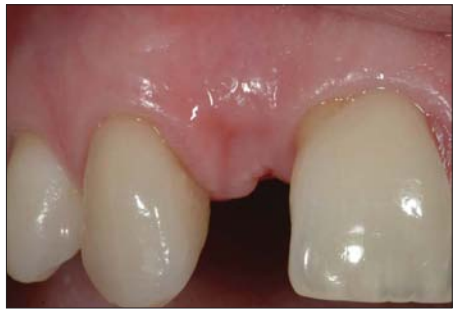

Figure 9f.

Figure 9. The extraction of a maxillary lateral incisor with a severe periodontal defect extending to the apex (a,b). The grafted socket covered with granulation tissue from the socket (c) and a slightly conical pontic placed (d). Healing at three months (e,f).

In areas of significant gingival insufficiency, a free gingival graft can be used as a barrier membrane (**Figures 8a-d**). The patient's own collagen is a very stable barrier from a free gingival graft, a connective tissue graft, or even the granulation tissue lining an infected socket (**Figures 9a-f**). It has been shown that the use of barrier membrane produces a loss of the soft tissue thickness overlying the bony ridge.[24] If loss of tissue thickness is of clinical concern, it can be avoided by the placement of a gingival graft as a barrier membrane which will increase the gingival thickness.

Postoperative Management

The loss of papillae height can be largely restored by the use of ovate pontics on removable or fixed provisional appliances (**Figures 10a-f**). In a socket that is augmented and is not an immediate implant site, an ovate pontic can be placed immediately. The pontic form can be altered during healing rapidly with light-cured resin to optimize the gingival form.

Conclusion

Today, the loss of alveolar ridge height and width can largely be avoided by extraction socket-preservation procedures (**Figures 11a-e**). The principles of guided bone regeneration, which are at the core of contemporary periodontal therapy, have evolved into the present generation of barrier membranes which greatly improve the overall result by not requiring primary closure. The supplemental addition of calcium sulfate to the graft materials appears to accelerate the rate of vital bone formation. In the future, these procedures are likely to become less invasive and more predictable. Barrier membranes may not be needed, and additional materials will be available that will accelerate the formation of bone. CDA

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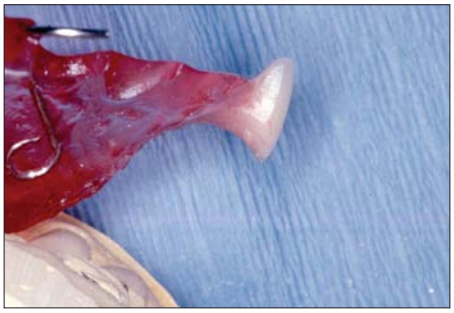


Figure 10a.

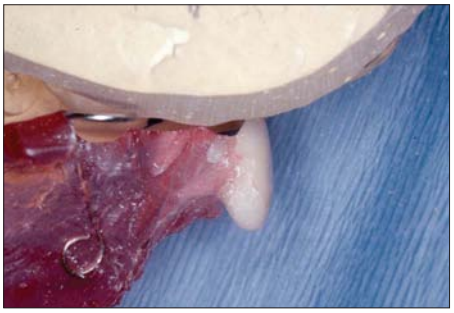
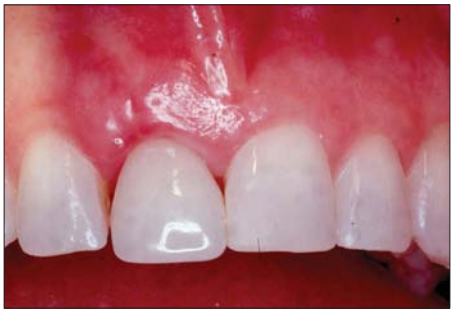


Figure 10b.

Figure 10c.



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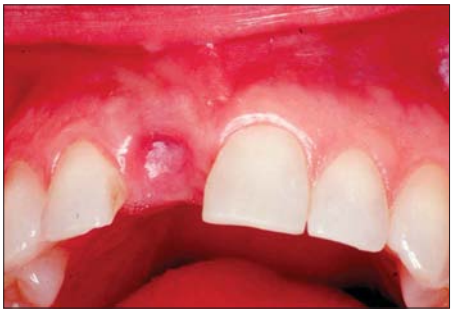

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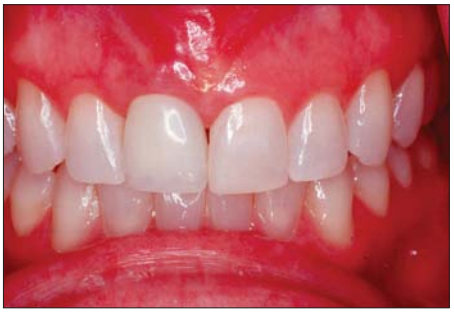
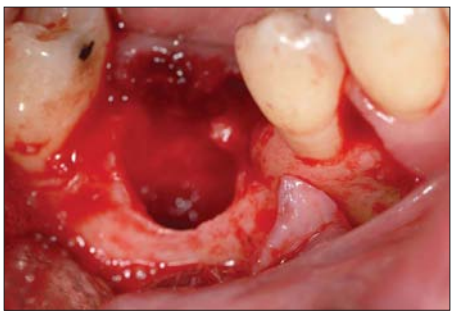


Figure 10f.

Figure 10. A typical temporary pontic modified to an ovate pontic form with the addition light-cured resin (a,b,c). The ovate pontic being placed into the extraction socket (d). Socket that has been shaped by the ovate pontic (e). A provisional crown on a dental implant showing the papillae height being maintained (f).



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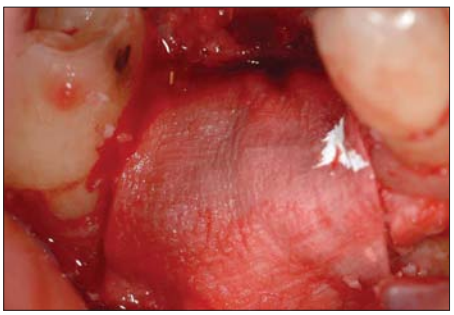

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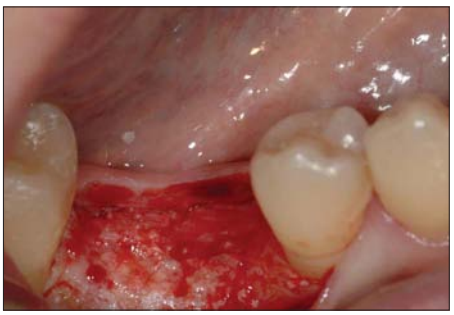

Figure 11c.

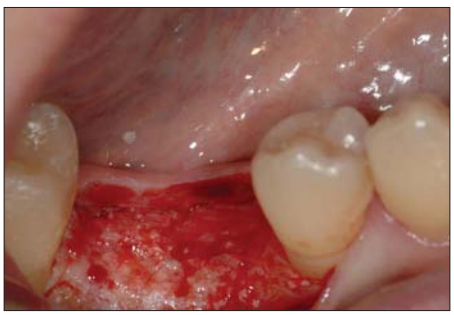

Figure 11d.

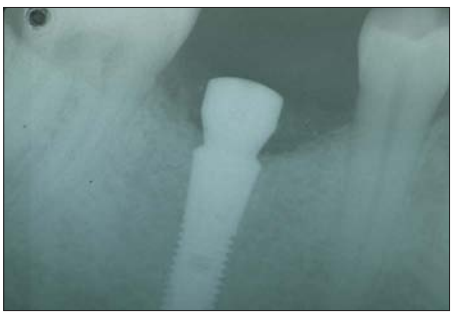

Figure 11e.

Figure 11. A mandibular first molar with significant bone loss including the buccal plate (a,b). The socket grafted with decalcified freeze-dried bone allograft, BioOs, and calcium sulfate, and covered with a Bio-Gide membrane (c). The healed alveolus at four-month surgical re-entry showing restoration of height and width (d). Radiograph of a dental implant at four months (e).

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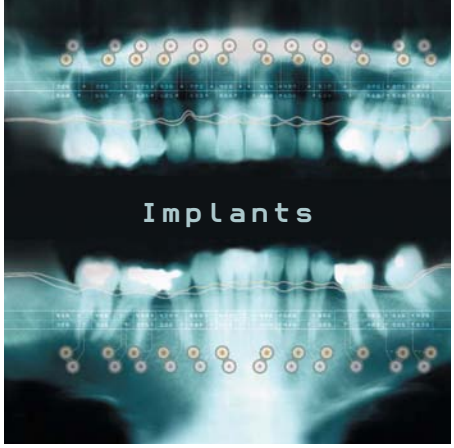

Anterior Esthetic Implants: Microsurgical Placement in Extraction Sockets With Immediate Provisionals

Dennis A. Shanelec, DDS

ABSTRACT

Dentists worldwide have hoped to realize the potential for dental implants for immediate replacement of failing teeth in the maxillary esthetic zone. This article is an analysis from private practice of a case series of 100 dental implants in the anterior maxilla placed under the microscope in extraction sockets with immediate implant-supported provisionals.

The most frequent traumatic tooth injury is a fractured crown of the maxillary central incisor in the permanent dentition.[1] Fractured teeth frequently follow a downhill course through bonding, endodontics, posts and crowns.[2] Many are lost to root fracture or root resorption.[3] For more than 100 years, dentistry's best answer to a missing tooth in the maxillary esthetic zone has been fixed bridgework.[4] This was usually preceded by extraction and a removable provisional, whose other designation "the flipper" is self-descriptive of its inherent limitations. Esthetic collapse of adjacent gingival tissue and loss of buccal alveolar bone are sequela familiar to dentists restoring patients following maxillary anterior tooth loss[5,6] (**Figure 1**).

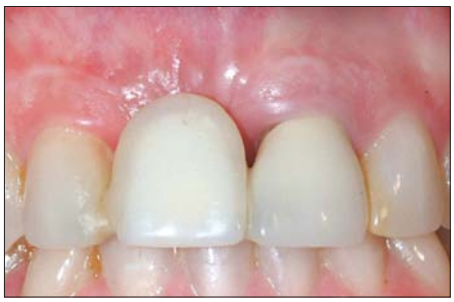

Figure 1. Ridge resorption following loss of central incisor.

Dental Implants and Tooth Loss

Since their introduction, dental implants have proven exceptionally predictable and successful in the edentulous and partially edentulous patient.[7-10] The biological and restorative improvements implants have undergone have increased their applications for single tooth replacement.[11,12] Dentists worldwide have hoped to realize the potential for dental implants for immediate replacement of failing teeth in the maxillary esthetic zone. This article is an analysis from private practice of a case series of 100 dental implants in the anterior maxilla placed under the microscope in extraction sockets with immediate implant-supported provisionals.

Surgical Trauma and Tooth Loss

Microsurgery is a movement in medicine and dentistry toward minimally invasive alternatives to replace

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The results described are achieved using a surgical microscope and may be statistically misleading when extrapolated to protocol not utilizing a surgical microscope.

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procedures that previously required extensive surgical incisions.[13] Using a microscope for surgery greatly enhances visual acuity and improves surgical dexterity.[14] Exodontia has been a traumatic procedure for centuries. Under a microscope, minimal invasive principles can be applied to tooth extraction. The aim of extraction microsurgery is to reduce trauma. Using a periotome luxator, a tooth root can be lifted vertically from its alveolar socket by carefully separating it from the surrounding ligament. This limits injury to the papilla and preserves natural gingival anatomy[15,16] (**Figures 2 and 3**).

The increased visibility provided under the microscope allows a surgeon to detect subtle nuances in the direction of luxation which are not apparent through normal vision, thus avoiding damaging the bone and gingival tissue.

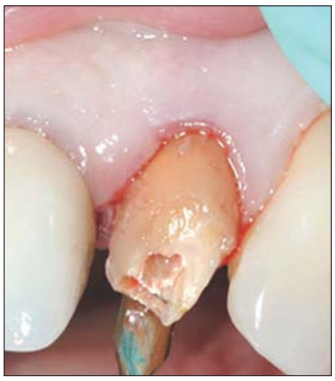

Figure 2. Periotome luxation of fractured root.

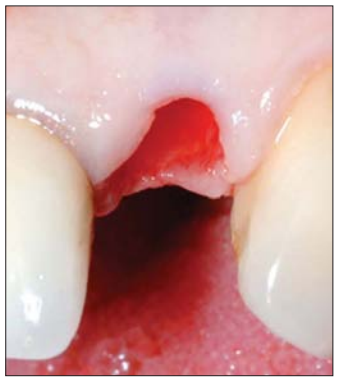

Figure 3. Periotome extraction site. Note lack of bleeding and trauma.

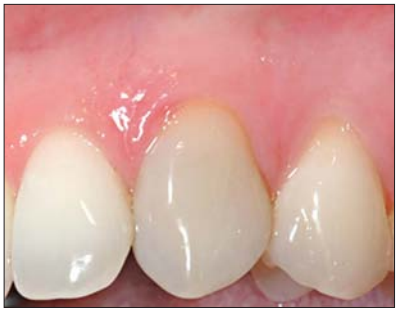

Figure 4. Preoperative failing cuspid.

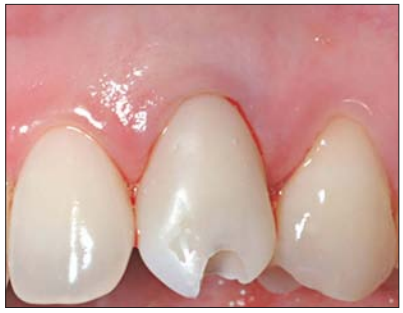

Figure 5. Provisional in placing with screw access opening.

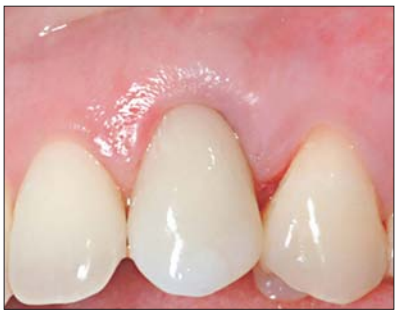

Figure 6. Provisional at time of microsurgery.

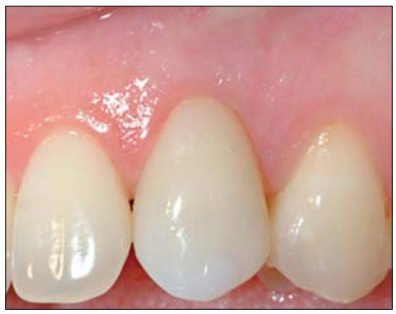

Figure 7. Provisional at eight weeks, ready for final restoration.

Implant Microsurgery

All phases of implant treatment may be performed using a microscope. Studies show that motor coordination and accuracy is generally increased when surgeons use a microscope.[17] Increased visual acuity, improved ergonomics, and body posture are closely related to those improvements.[18] In medicine, microsurgery has significantly reduced postsurgical pain in a variety of surgical disciplines.[19] Likewise, in endodontics, microsurgery has demonstrated measured reduction in postoperative pain.[20] Although no studies establish that microsurgery reduces postoperative pain following extraction or implant placement, there is strong theoretical rationale to suggest that less surgical trauma results in less pain and faster healing, and that microsurgery leads to those ends. The author's experience has shown that extraction under the microscope with implant placement in the socket followed by an immediate anatomical provisional reduces visible surgical trauma and prevents soft tissue collapse following tooth removal. Anecdotally, patients describe their discomfort level as inconsequential (**Figures 4-7**).

Materials and Methods

Patient Selection

This study comprises a case series of 100 consecutive patients in private practice requiring extraction of maxillary central incisors, lateral incisors, or cuspids. No exclusion criteria were employed. Teeth were extracted due to vertical root fracture, horizontal root fracture, root resorption or endodontic failure. One hundred implants were placed in extraction sockets and implant-supported screw-retained provisionals were delivered at the time of surgery. Preoperative and postoperative images were digitally recorded and cataloged in Extensis Portfolio image data-

base for easy retrieval and analysis. Preoperative and postoperative radiographs were taken utilizing a Rinn film holder. These were taken without the benefit of a custom-acrylic bite plane to standardize angulation.

Surgical Technique

Tooth extractions were performed using periotome luxation. The sockets were debrided of granulation tissue and the sulcus de-epithelialized with a flame diamond. The sockets were irrigated, then filled for 30 seconds with 3 percent tetracycline solution. Lateral cutting burs were used to correct angulation between each incremental increase in twist drill size. Following completion of the osteotomies, implants were inserted utilizing a drilling unit set to 67 ncm torque and 25 rpm. All patients received NobelBiocare Mark IV 4.0 mm-diameter threaded implants with textured surfaces and 2-degree thread taper geometry.[21] Of 100 implants placed, 89 were 15 mm in length, nine were 18 mm in length, and two were 13 mm in length. In 81 implants, bone collected through aspiration filtration from the osteotomy preparation was rinsed with sterile water, dried and saturated with 3 percent tetracycline, then placed over any buccal thread dehiscence within the socket. Particulate bone zenograft was used to fill the remaining void between the implant and socket wall. A layer of collagen was placed over grafted bone before the implant provisional was placed. In 28 cases, preoperative buccal tissue height or thickness was judged deficient. In those cases, at the time of surgery, connective tissue was transferred from the palate into shallow subepithelial envelope incisions on the buccal. This was done to restore or maintain normal gingival height.

Drilling in the Extraction Socket

Implant drilling under the microscope is a revealing experience. The socket appears as large as a room with the apex and walls clearly visible. Drilling in extraction sites requires a different set of skills than drilling in edentulous sites.[22] The most favorable bone in the anterior maxilla lays to the palatal and apical of the socket[23] (**Figures 8 and 9**).

For this reason, drilling must be done at an oblique angle to the socket wall. Twist drills are not designed for this purpose. They track in the direction of less dense bone and into the open socket. Unless the osteotomy site is redirected with lateral cutting burs before each incremental increase in twist drill size, the implant angulation and position will invariable move buccally. With the magnification and lighting a microscope provides, drilling in the lateral socket wall can be accomplished for stable and accurate esthetic positioning of the implant in the socket.

Immediate Implant Provisional

To preserve natural esthetics, an implant provisional must emerge from the surrounding gingiva exactly like the extracted tooth.[24,25] There is no margin for error. Creating a provisional crown begins before the tooth is removed.[26] A clear silicone impression is made, capturing the dento-gingival junction. A light-cured composite resin duplicate of the tooth is fabricated from the impression (**Figures 10-12**).

The duplicate tooth is trimmed to the exact location of the dento-gingival

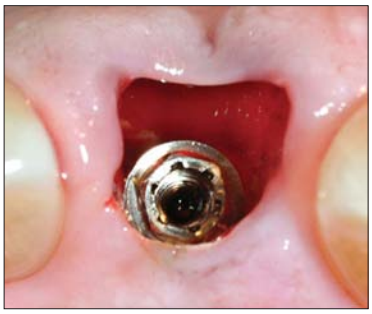

Figure 8. Implant properly placed in lingual side of socket. Note immediate tissue collapse on the buccal without provisional support.

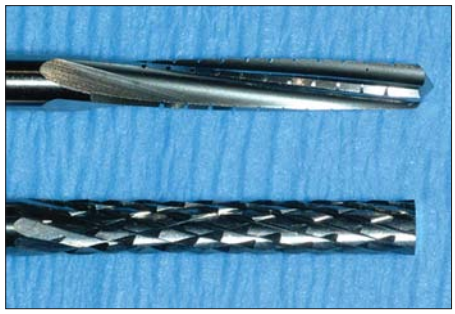

Figure 9. Lateral cutting burs for osteotomy preparation in the lateral wall of the socket.

Figure 10. Blank replica of failing tooth.

Figure 11. Replica tooth hollowed and shaped. The rough surface facilitates adding flowable composite to create ideal tissue support.

Figure 12. Polished and glazed provisional with proper subgingival profile.

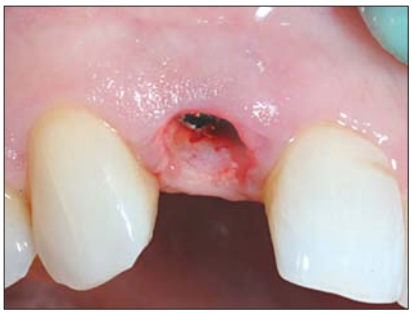

Figure 13. Lateral incisor removed microsurgically with implant in place.

Figure 14. Opaqued titanium screw-retained abutment on implant.

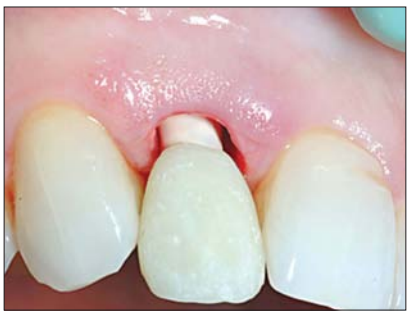

Figure 15. Replica tooth fitted to abutment.

Figure 16. Replica tooth bonded to the temporary abutment with light-cured composite.

Figure 17. Final finished and polished provisional crown.

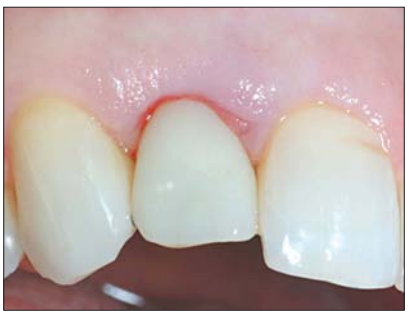

Figure 18. Provisional crown at time of implant microsurgery.

Figure 19. Provisional crown at eight weeks, ready for final restoration.

junction. The replica tooth is hollowed for luting to a titanium screw-retained temporary abutment. The outer surface of the titanium abutment is opaqued to provide accurate color match. The temporary titanium abutment is placed on the implant and the duplicate crown filled with light-cured composite then joined to the abutment. (**Figures 13 and 14**).

This provisional crown is removed utilizing a screw access opening in the incisal third. The subgingival profile is individually shaped for each patient at the time of surgery.[27] Voids and rough edges are eliminated, and the provisional carefully contoured to support the gingival tissue. As a final step, it is polished and glazed (**Figures 15-18**).

Using light-cured composite assures that no free monomer is present to irritate tissue or bone. The machined titanium provisional abutment reduces the possibility of the provisional loosening. In this study, of the 100 provisionals placed, screw loosening occurred in one patient (**Figure 19**).

Provisional Occlusion

Early loading bone forces are controlled in multiple implant immediate loading cases through splinting.[28] Early loading bone forces in single implant cases are controlled by eliminating centric and lateral occlusal contact. Symmetrical and light mesial and distal contacts are established and the provisional is taken completely out of centric and lateral occlusal contact using green occlusal indicator wax. This protocol allows patients to leave the dental office with a non-loaded esthetic provisional tooth securely anchored to the dental implant.

Final Esthetic Restoration

An immediate provisional crown assures that patients are never without a natural-looking tooth. Because the gingiva is never unsupported, natural tissue height and contour can be preserved. The subgingival emergence profile of the provisional must be accurately registered and transferred to the ceramicist.[29-31] This transfer of subgingival anatomy is accomplished through an impression made of the gingival third of the provisional crown with an implant analog attached. The impression is used to create a custom impression transfer coping which duplicates

the subgingival emergence profile of the provisional[32-34] (**Figures 20-23**).

After final impressions with the custom impression transfer coping, computer-assisted scanning and machining then creates a final Procera Zirconia ceramic abutment and ceramic crown[35,36] (**Figures 24 and 25**).

This process assures that the final abutment exactly matches both the original tooth shape and the provisional emergence profile. Working together as a team, surgeons, restorative dentists, and ceramists can combine their skill and knowledge to create a tooth in harmony with adjacent gingival anatomy and the overall appearance of face and smile (**Figures 26-29**).

For many patients, traumatic anterior tooth loss is their first exposure to implant dentistry. In the author's experience, patients are pleased with the simplicity of a technique which does not involve major incisions, suturing, raising of mucogingival flaps or the need for multiple surgical procedures. They frequently comment on the "sturdiness" of their provisional and lack of pain associated with the procedure (**Figure 30**).

Figure 20. Impression of provisional crown is taken before it is placed on the implant.

Figure 21. Registration of the provisional crown emergence profile.

Figure 22. Clear acrylic reproduces provisional emergence profile.

Figure 23. Custom impression transfer coping polished and glazed.

Figure 24. Zirconia all-ceramic implant abutment.

Figure 25. Procera all-ceramic crown

Clinical Results

Using the described protocol, 100 implants were placed over a 36-month period. The average follow-up time was 18 months. Of 100 implants placed, 98 implants were approved for restoration at eight weeks and successfully restored. Two implants failed to integrate before restoration. These were removed and replaced, then provisionalized with bonded pontic provisionals prior to restoration. The clinical success rate for implants placed using this protocol was 98 percent based on the following parameters:

- Absence of clinical inflammation, infection or bleeding on probing
- Absence of mobility, pain or sensitivity of the implant or surrounding tissues
- Soft tissue sulcus less than 1 mm beyond the implant platform
- Ability to withstand rotational torque of 45 ncm at abutment insertion
- Radiographic evidence of bone to within the topmost thread of the implant
- The implant is restored and remains in clinical function

Discussion

Dental implants originally followed a protocol which required lengthy periods of undisturbed healing before loading, typically three and six months.[37-39] Immediately loading of full arch splinted implants is now accepted therapy.[40-43] Immediate loading of single tooth implants has also proven successful.[44-49] Combined data from six studies, comprising 287 single tooth implants immediately loaded showed a 96.7 percent survival rate.[50] Seven studies have examined the outcome of implants placed in extraction sockets of the anterior maxilla

with immediate provisionals.[51-57] Combined data from these studies comprised 190 implants and showed a 95.9 percent survival rate.[58] The successful outcomes described by these investigators have proven controversial. Reviewing these seven studies, Ganeles and Wismeijer stated, "It should be recognized that, with few exceptions, these conclusions may be misleading statistical phenomena of the authors, as most publications were written by exceptionally experienced, highly skilled practitioners working under tightly controlled clinical conditions on a relatively small, statistically inconclusive number of implants and patients."

Such ad hominem arguments marginalizing obviously successful results reflect the frustration experienced by many clinicians who attempt immediate provisionals on implants placed in extraction sockets. However, our current study confirms a high clinical success rate of implants placed microsurgically in extraction sockets of the anterior maxilla with immediate provisionals. Comprising 100 consecutive implants, it is the largest study to date examining this protocol. The operator skill requirements and technical demands of the protocol are admittedly high. It is the author's opinion that optical magnification afforded by the microscope increases the precision of placement and initial stability during implant microsurgery. In addition, the minimal invasiveness and reduced surgical trauma of microsurgically placed dental implants may contribute to rapid healing, lessened morbidity and successful osseointegration.

Clinical success describes the basic survival, health, comfort, and function of dental implants but does not define esthetic success. In implant dentistry, evidence-based statements regarding esthetic procedures are difficult to generate. Most studies focus on implant survival. Scientific evidence of esthetically reproducible parameters is rare. The stability of soft tissue esthetics around single tooth implants has been studied. Significant regeneration of mesial and distal papilla was shown after a follow-up period of 1.5 years.[59] On the other hand, soft tissue buccal recession of 0.6 mm was also shown after one year.[60] This has led to a consensus that a provisional restoration with adequate emergence profile should be used to guide and shape the peri-implant tissue prior to final restoration.[61] Priest proposed an esthetic analysis based on soft tissue gingival height around dental implants. In his analysis, the positions of midfacial gingival tissue margin and the heights of mesial and distal papillae were numerically compared using fixed reference points on preoperative and postoperative photographs. Our current study utilized a variation of Priest's analysis as a subjective measure of esthetic outcome on a visual analog scale. Based on before and after digital photographs, the gingival anatomy remained unchanged or improved in 95 patients. Five patients required postoperative connective tissue grafts to bring the gingival zenith to preoperative levels. A more comprehensive numerical digital analysis of this case series will be forthcoming in future publications.

Belser, Buser and Higginbottom defined an esthetic implant crown as one in harmony with the perioral facial structures. In addition, the soft tissues, including, height, volume, color, texture and contours, should be in harmony with the surrounding teeth. Finally, the restoration should imitate the natural appearance of the missing tooth.[62] This study shows that microsurgery can be utilized for implant placement in extraction sockets with a high degree of

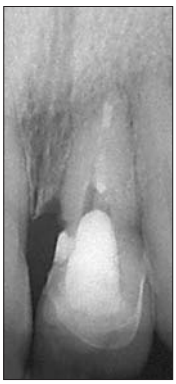

Figure 26. Preoperative X-ray of failing central incisor.

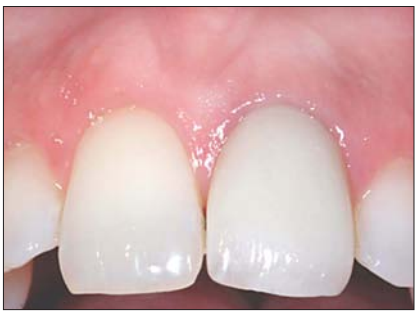

Figure 27. Preoperative central incisor.

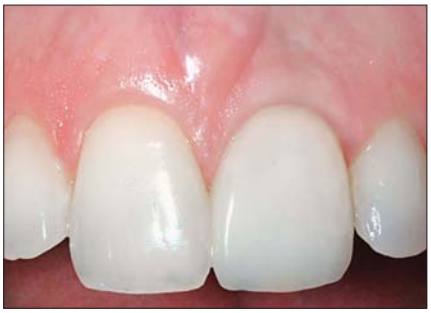

Figure 28. Postoperative implant at 44 months.

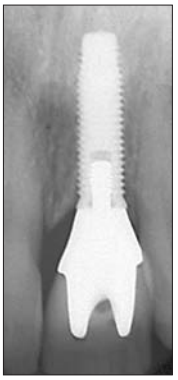

Figure 29. Postoperative X-ray at 44 months.

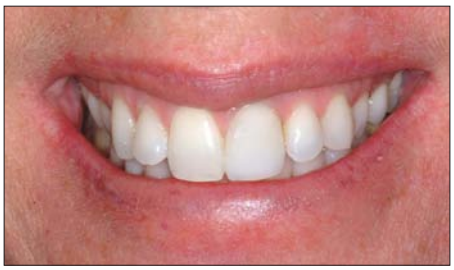

Figure 30. Smile line esthetics with implant and crown (Restoration courtesy Kathleen McClintock, DDS).

clinical success. When provisionals are placed at the time of surgery, the gingival tissues are supported and undergo little change in anatomy. This protocol offers an opportunity for implant therapy with less morbidity and highly esthetic outcomes. This translates into increased patient acceptance and satisfaction.[63] Dentistry will see increasing use of the microscope in clinical practice, including applications for extraction, implant placement and restoration.[64] Microscopy has the potential to advance dentistry from an era of traumatic tooth loss to one of exact and seamless replacement of a failing anterior tooth with an esthetic implant-supported crown. CDA

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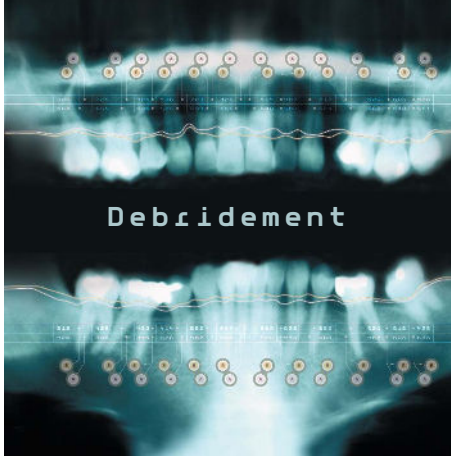

Enhanced Periodontal Debridement With the Use of Micro Ultrasonic, Periodontal Endoscopy

John Y. Kwan, DDS

ABSTRACT

Current literature supports the use of powered instrumentation over traditional hand instrumentation. The objective of scaling and root planing is the complete removal of plaque and calculus from root surfaces. While this is unrealistic, the accepted end-point is a smooth, glassy root surface during periodontal instrumentation. This often has resulted in overinstrumentation and excessive removal of cementum. Cementum removal has been deemed generally unnecessary. What is essential is the removal of plaque, calculus, and the endotoxin adherent to the root surface. This cleaning of root surfaces is best done with judicious use of powered instrumentation. The excessive removal of cementum during hand instrumentation is due to the lack of visualization. Using endoscopic technology, the ability to visually debride roots can improve chances of success in a more conservative and minimally invasive way. This article provides a brief review of micro ultrasonic technologies and periodontal endoscopy, its implementation in our practice, and a limited case series.

The treatment of periodontal disease has always revolved around the effective debridement of the subgingival environment and the control of the microbial flora associated with the disease. There are multiple modalities available. Traditional nonsurgical treatment can be successful, but is limited by the lack of visualization. Alternatively, surgical treatment permits access to the root surface for visual debridement.[1]

There are a multitude of hand and powered instruments available. Hand instruments require sharpening and are limited in their access to root surfaces due to their size and shape. This is especially true with deeper periodontal pockets.[2] Additionally, the forces required to use hand instruments increase the risk for repetitive stress injuries. Alternatively, powered instru-

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Disclosure / At the time Dr. John Kwan wrote this article, he received an honorarim for providing presentations for Dental View. He currently is a paid consultant for Dental View.

Figure 1. Periodontal endoscope.

Piezo Technology

Advantages	Disadvantages
Larger handpieces	Screw-in tips (not recyclable)
Lighter	Multiple handpieces needed to avoid screwing in tips
No water needed for cooling (water is for lavage)	Linear movement with straight tips
	Auto tuned only
	Expensive
	More discomfort than magnetostrictive

Figure 2.

Magnetostrictive Technology

Advantages	Disadvantages
Pop in/out inserts	Many auto-tuned machines are overpowered
Swivel/rotate	Auto tuning creates more water spray
Manual tuning available	Inadequate water flow can produce excessive heat
Any hand instrument can be made magnetostrictive	Manual tuning not as easily understood as auto tuning
Elliptical tip movement; better power distribution	
Inserts are recyclable	
Heat production warms H_2O	
More affordable than piezo	
Widely used in the U.S.	

Figure 3.

mentation can allow providers to treat with less risk of repetitive stress injury, and more predictably access the entire root surface due to the availability of smaller size instrumentation.[3]

The periodontal endoscope (Dental View, Lake Forrest, Calif.) (**Figure 1**) allows for visual access to root surfaces with great magnification, lessening the need for surgical intervention. Combined with a simple array of micro ultrasonic instruments, endoscopic debridement can be accomplished in a conservative, minimally invasive way by the dentist, periodontist or dental hygienist.

The author's office has incorporated both powered micro ultrasonic and endoscopic techniques such that it provides a subjectively more effective periodontal debridement. The incorporation of these techniques requires developing some office protocol, but the case series presented suggest these efforts may be worthwhile.

Micro Ultrasonics

Micro ultrasonics is a term coined in the early '90s by the author and Peggy Hawkins, RDH. It is a generic term that identifies the refined use of powered instrumentation used for high-powered, supragingival, gross debridement. Micro ultrasonics instrumentation is small, approximating the size of a periodontal probe and can be used for supra- and subgingival treatment at low to high power, with less to no water spray, and little or no adjunctive use of hand instrumentation.[4]

The American Academy of Periodontology position paper on sonic and ultrasonic scalers in periodontics indicates that both power-driven and hand instrumentation provide similar clinical outcomes when one examines the various parameters associated with scaling and root planing: plaque removal, endotoxin removal and wound healing. However, when appropriately used, power-driven scalers may cause less root damage and/or excessive cementum removal. Complete removal of cementum in an attempt to eliminate endotoxin adherent to the root surface is unnecessary and may result in treatment complications like hypersensitivity. Additionally, the power-driven instruments may provide better access to the base of the pocket and furcations.[5-7]

This position paper indicates a paradigm shift in that no longer is the clinical objective the production of a smooth, glassy root surface but the adequate removal of plaque, calculus, and

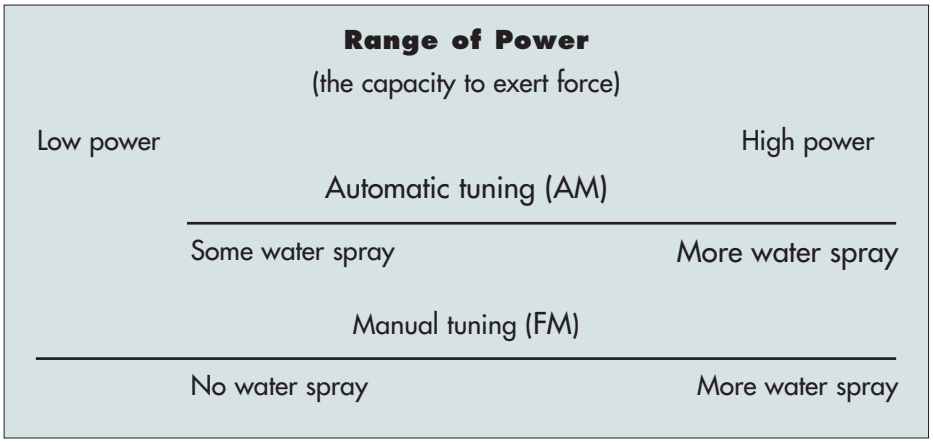

Figure 4.

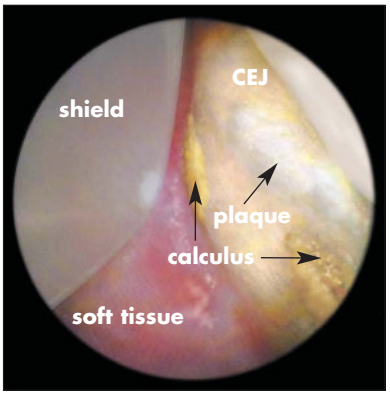

Figure 5.

its associated endotoxin such that the microenvironment permits periodontal healing. The implied message is that cementum removal is not recommended for periodontal debridement. Clinically, when root planing is performed with sharpened or abrasive instruments, the only indicator for a treatment end-point is the production of a smooth, glassy root surface. This invariably results in the intentional removal of cementum. Are we overinstrumenting roots unnecessarily?[8] Micro ultrasonic instruments are less likely to overinstrument roots because they are generally not sharp or abrasive.

Comparing micro ultrasonic instruments to hand instruments, hand instruments are large (.75 mm to 1.5 mm blades), and require manual force with limited active/working sides (one or two micro ultrasonic instruments are probe-like (measuring .2 to .6 mm in diameter), powered to move up to ultrasonic speeds (25,000 to more than 40,000 cycles per second), with active working sides on all surfaces of the vibrating instrument, and provide ultrasonically activated lavage in the working field.

Today's ultrasonic equipment is either magnetostrictive or piezo technology. Magnetostrictive technology creates instrument vibrations by electrically activating strips of metal in the ultrasonic insert. The frequency of vibrations is typically 25,000 or 30,000 cycles per second. The tip vibrates in a linear movement with lateral wobble, which is usually described as being "elliptical." Piezo technology creates instrument vibrations (generally more than 40,000 cycles per second) by electrically activating a quartz crystal and transferring the vibrations to the instrument tip. The tip vibrates in a very efficient linear movement. However, this produces a greater discrepancy of power between the front and the back of the instrument, and as well as from side to side.

Ultrasonic equipment can be purchased with either automatic tuning or manual tuning. Automatic tuning, "automatically" tunes the tip of the instrument to optimal vibration by a feedback loop, and power changes are made by amplitude adjustment, which creates incrementally larger or smaller vibrations. Manual tuning allows for modulation of the amplitude and the frequency. The use of manual tuning allows the clinician more flexibility in the production of vibrations for cleaning teeth. In addition, manual tuning can produce various levels of power from very low to very high, with better control over reducing the water spray, especially at the low to medium power levels. This is possible because at any amplitude level (power setting) the provider can "manually" tune or "detune" the vibrations (frequency setting) and gain more control over the instrumentation. Magnetostrictive ultrasonic units can be found with either manual or automatic tuning, or both, while piezo units are available only with automatic tuning (**Figures 2-4**).

Clinical Research Associates, in its clinical evaluation of ultrasonic equipment, concluded that ultrasonic scalers can remove tenacious hard deposits with less patient and operator discomfort, and with less overall chair time. It was concluded that the purchase cost was not an indicator of its performance or features. Lastly, it was concluded that manually tuned units gave superior performance, although required tuning, and re-tuning when changing inserts.[9]

Periodontal Endoscopy

The periodontal endoscope allows for subgingival visualization of the root surface at magnifications of 24x to 48x (**Figure 5**). This is accomplished through a .99 mm fiber optic bundle that is a combination of a 10,000-pixel capture bundle surrounded by multiple illumination fibers. This fiber is delivered to the gingival margin coupled into an instrument called an "explorer." A single-use sterile sheath isolates the fiber so it can be used

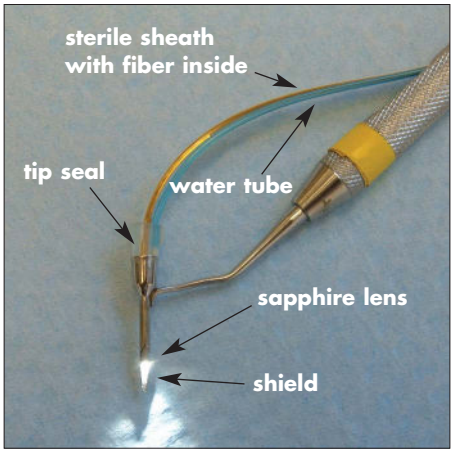

Figure 6. Endoscopic explorer.

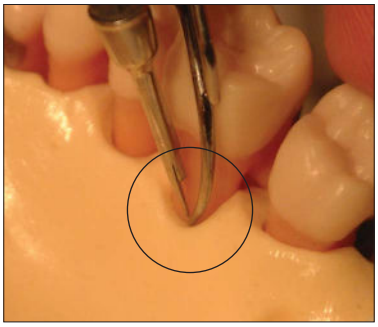

Figure 7. Camera and micro ultrasonics for endoscopic instrumentation

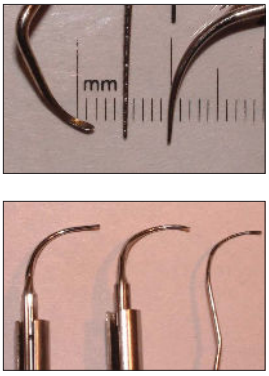

Figure 8. (Top) Scaler, probe amd micro ultrasonic insert. (Bottom) Angled insert, modified curved/ angled insert, and furcation probe.

repeatedly (average use for the author has been 70 to 80 uses per fiber). The captured image is relayed to a screen so that the user can see "real time" video of the highly magnified environment (approximately 3 mm on screen at a time).

The explorers come in shielded or nonshielded configurations. The shielded explorers are used for periodontal debridement. They provide a mechanism for viewing subgingivally while "pushing" the soft tissue away from the camera lens which is recessed from the tip of the shield. This space from the tip of the shield to the camera lens (~4 mm) allows for instruments to be placed within the viewing field for simultaneous viewing and instrumenting or "endoscopic debridement." These explorers are available in angulations or can be bent to allow for access into various surfaces around the tooth.

The sheath, which isolates the fiber from the oral environment, is made up of two tubes: One isolates the fiber and the other delivers water to the end of the fiber or camera lens. They both merge in a part of the sheath called the "tip seal" which fits into the explorer. Extending from the tip seal is a rigid metal tube with a very small sapphire lens. This metal tube and the tip seal secure the camera lens at the appropriate distance from the end of the shield and allows for clear visualization while isolating the fiber and allowing for water flow into the area of interest (**Figure 6**).

Protocols for Incorporating Micro Ultrasonic and Endoscopic Technology

The incorporation of these techniques require both financial, time, training, and operational changes in the office protocol. In this section, adaption of these techniques and encountered difficulties in the author's office is discussed.

Candidates for endoscopy: Candidates for endoscopy include patients being treated for the following: initial periodontal therapy; sites that did not respond to traditional nonsurgical treatment; residual pockets in patients who are resistant to surgical therapy and where surgery is contraindicated (medical reasons, or esthetics); during maintenance for chronically inflamed or increasing pockets; suspected subgingival pathology such as caries, root fractures, perforations or resorption; and cases requiring documentation, such as for litigation.

Use the two-handed technique: Endoscopic instrumentation is a difficult task to master. It requires a desire to learn, focused attention, lots of practice, and much patience. The best way to provide endoscopic care is by using the two-handed technique. For a right-handed person, the endoscope is placed in the left hand and the instrument (preferably micro ultrasonic) in the right hand, viewing and instrumenting (or cleaning) at the same time (**Figure 7**). It is not recommended to place it with the right hand, then switch and hold with the left hand, then instrument with the right hand. Nor is it recommended to use only one hand to view, then instrument and then view. On occasion, using the two-handed technique, you may need to view, instrument and then view again, while still keeping the endoscope and instrument in their respective hands.

Automate your debridement: In the author's office, the micro ultrasonic instrumentation is the preferred method for periodontal debridement. To improve efficiency, automate your endoscopic debridement using powered micro ultrasonic instrumentation only and limiting your instruments. The author typically uses one straight, and two curved/angled micro ultrasonic instruments (Tony Riso Company, Miami, Fla.) (**Figure 8**). "Focus" on using the two-handed technique and view while instrumenting, as the objective is to see what you are doing, not just to see what you have done. The use of the dental mirror is very similar to using the endoscope in the nondominant hand, which is not easy at first, but becomes

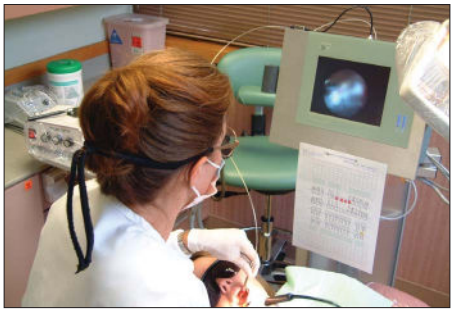

Figure 9a. Eyes on screen.

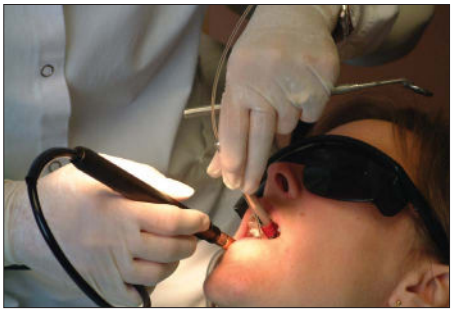

Figure 9b. Two-handed technique.

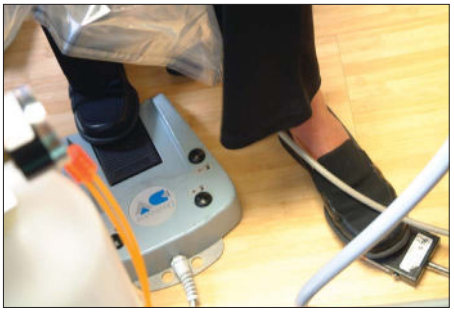

Figure 9c. Bilateral pedal operation.

routine for dental providers. In fact, with practice it becomes simple to maintain the hold on the mirror, while simultaneously using the endoscope in the same hand (**Figure 9**).

Endoscopic treatment options: Endoscopic treatment options for periodontal disease include the following options:

Secondary use: Patients go through traditional tactile debridement followed by re-evaluation; then sites that have not responded are endoscopically debrided.

Primary use: Patients do not go through a separate tactile debridement; they have initial endoscopic debridement followed by re-evaluation.

Patient introduction to endoscopy: Patients should be educated on their diagnosis, the etiology of their problem(s) and given options. In the case of periodontal disease, patient options typically include: doing nothing, which is not recommended for the health of the teeth or body; nonsurgical treatment, which can be accomplished visually with endoscopy; surgical debridement (typically more invasive and more expensive); and/or referral for a second opinion.

Patient selection and getting started: Most practices have existing patients with long-standing periodontal problems, or there may be patients who are resistant or refuse specialist referral. These patients, along with patients who

Patient Care with Micro Ultrasonic, Endoscopic Periodontal Debridement

Check functions prior to seating patient.

Water flow, light source, sheath

Premedicate with over-the-counter NSAID

Practice pre-emptive pain management.

Use adequate topical and local anesthetic

Allows for comfortable and liberal treatment without pain or sensitivity

Patience

Coordinating hands/feet, pedals/instruments

Simplify

Start and finish with one explorer in each segment before starting to use another explorer.

Start and finish with one instrument in each segment before starting to use another instrument.

Use powered instrumentation only.

Eyes on screen

Get micro ultrasonic tip and endoscope explorer adjusted; use screen to govern movements.

Power

Use medium to medium plus power with micro ultrasonics.

Pressure

Use lateral pressure for more power. (This is contrary to most teaching but is very evident when cleaning endoscopically.)

Movement

Use smaller movements over deposits.

Post-treatment phone call

Follow-up call the next day; extends care, exceeds expectations

Figure 10.

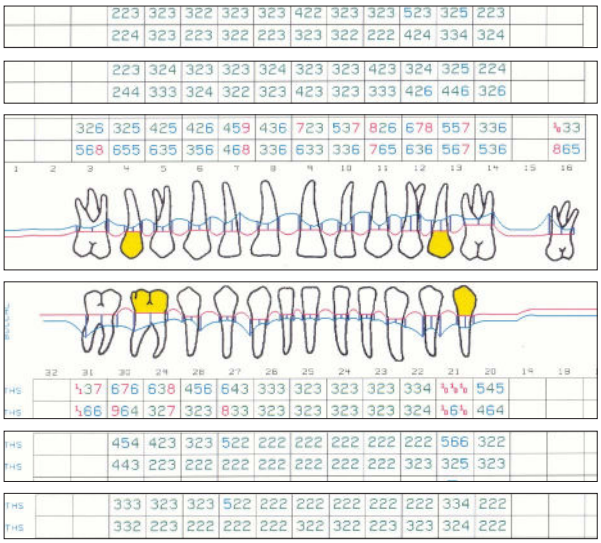

Figure 11. Patient No. 1 initial, six-week and 18-month probings (from inside going out).

present with localized moderate problems, are good candidates for periodontal endoscopy. It may be prudent to try initial tactile debridement and treat nonresponding sites. Initially, 90- to 120-minute appointments for pocketing in one to two quadrants is ample time to use the endoscope.

Providers should practice the two-handed technique on models and focus on the screen to get used to video image interpretation and coordinating movements. Patient care should include adequate topical and local anesthesia. Getting the endoscope and a micro ultrasonic instrument into the small subgingival environment is much easier when the provider and the patient do not have to be concerned about tenderness or sensitivity. Learn the patterns of explorer use (not within the scope of this article). Initially "scope" the areas of interest. Later, start to move around each tooth in the sextant or quadrant. With more experience and more speed, add more teeth to scope, and then consider doing this as initial treatment (**Figure 10**).

As a new provider, try to do at least one case per week to get and stay familiar with the equipment and technique. Expect the initial learning curve to take up to 10 patients. A "comfort zone" should start between 20 to 30 patients. Make an effort to get feedback from other endoscope users.

Where endoscopy is difficult: There are areas where endoscopy is difficult. In shallow pockets, the water that is not well contained, does not allow for a clear flooding of the area between the tooth and the camera lens. It is helpful to angle the explorer more parallel with the tooth surface to get the camera closer to the tooth. Very inflamed pockets and abscessed areas can have excessive bleeding and boggy soft tissue that can make visualization difficult. It is very important to have adequate water flow to help keep the lens clear. Distal furcations of maxillary molars tend to be in the middle third of the tooth and access may be more difficult for the instrumentation than for the endoscope. Narrow furcations and Class III furcations are difficult to visualize because the explorer will not fit into some of these areas due to size limitations. Curved roots, root proximity and grossly overcontoured restorations create access problems for the endoscope and instruments. Limited jaw opening creates access problems for any type of instrumentation as well as the endoscope.

Cost effectiveness for periodontal endoscopy: The incorporation of periodontal endoscopy requires financial, time, training, and new office logistical commitments. Can additional billings cover reoccurring costs of the sheaths and occasionally a new fiber? Can additional billings cover financing and increase profit? Can this technology provide career advancement for the dental hygiene staff? Will use of the endoscope improve patient care? Can this technology enhance referrals into the general or periodontal practice? The answers to these questions should be considered prior to investing in this technology. If a practice has or can attract patients who can benefit from periodontal endoscopy, and the providers are willing to learn and provide this skill, then, the feasibility and profitability of incorporating periodontal endoscopy should be considered.

Case Presentations

Patient No. 1:

This 71-year-old female presented with a diagnosis of generalized moderate to advanced chronic periodontitis. In addition to actual attachment loss, she presented with notable soft tissue inflammation. Her medical history was negative with the exception of a history of high-blood pressure that was well controlled with medications. Her treatment plan consisted of full-mouth micro ultrasonic debridement, with adjunctive endoscopic debridement, and the removal of Nos. 3, 16 and 31 (No. 3 was fractured; and Nos. 16 and 31 were nonfunctional). She was premedicated with an over-the-counter, nonsteroidal anti-inflammatory analgesic drug prior to the procedure, and all four quadrants were anesthetized with local anesthetic. The procedure was scheduled for 2½ hours; the extractions were done as part of the treatment in each respective quadrant. General tactile debride-

Figure 12. Patient No. 2 initial, six-week and 14-month probings (from bottom to top).

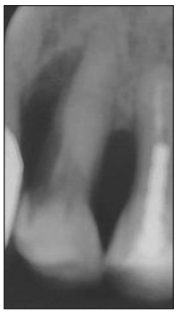

Figure 13a. Patient No. 2 before treatment

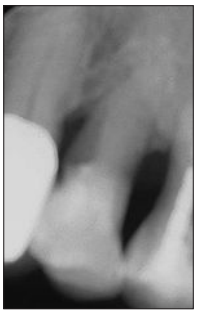

Figure 13b. Patient No. 2, 14 months after treatment.

ment was done to remove plaque and reduce the level of subgingival calculus, followed by endoscopic debridement in the areas of pocketing. The patient was given a short course of a systemic antibiotic (Zithromax, Pfizer) to serve as an adjunctive disinfectant to the debridement (further discussion regarding the adjunctive use of local and/or systemic antimicrobials is not within the scope of this paper).[10-14] The patient was seen for re-evaluation at six weeks post-treatment, supportive periodontal treatment consisting of micro ultrasonic debridement was performed at three-month intervals and another re-evaluation was recorded at 18 months post-treatment (**Figure 11** shows the improvement in clinical probing depths).

Patient No. 2

This 76-year-old female presented with a diagnosis of localized moderate to advanced chronic periodontitis, in the maxillary arch only. Her medical history indicated diagnoses of high-blood pressure and osteoporosis, and she was taking appropriate medications for treatment. Her treatment plan consisted of full-mouth micro ultrasonic debridement, with adjunctive endoscopic debridement. She was premedicated with an over-the-counter, nonsteroidal anti-inflammatory analgesic drug prior to the procedure and both maxillary quadrants were anesthetized with local anesthetic. The procedure was scheduled for 70 minutes. General tactile debridement was done to remove plaque and reduce the level of subgingival calculus, followed by endoscopic debridement in the areas of pocketing. The patient was given a short course of a systemic antibiotic to serve as an adjunctive disinfectant to the debridement. **Figure 12** shows the initial clinical probing depths and at the six-week re-evaluation, all areas of pocketing were showing improvement with the exception of No. 12 mesial. This site was re-treated with micro ultrasonic, endoscopic debridement and an adjunctive local delivery antibiotic was placed (Arestin, Orapharma). The patient was seen for supportive periodontal treatment consisting of micro ultrasonic debridement at three-month intervals and was re-evaluated clinically and radiographically at 14 months post-treatment. **Figure 13** shows her radiographic change from before to 14 months post-treatment.

Patient No. 3

This 65-year-old male presented with a diagnosis of localized moderate to advanced chronic periodontitis. His medical history was negative, with the exception of a history of high-blood pressure that was well controlled with medications. His treatment plan consisted of full-mouth micro ultrasonic debridement, with adjunctive endoscopic debridement. He was premedicated with an over-the-counter, nonsteroidal anti-inflammatory analgesic drug prior to the procedure and three quadrants were anesthetized with local anesthetic. The procedure was scheduled for two hours. General tactile debridement was done to remove plaque and reduce the level of subgingival calculus, followed by endoscopic debridement in the areas of pocketing. The patient was given a short course of a systemic antibiotic to serve as an adjunctive disinfectant to the debridement. The patient was seen for re-evaluation at six weeks post-treatment, supportive periodontal treatment consisting of micro ultrasonic debridement was performed at three-month intervals, and another re-evaluation was recorded at 18 months post-treatment. **Figures 14** and **15** show the clinical and radiographic response on the lower right molars, from before to 18 months post-treatment.

This small case series provides examples of the positive responses possible with micro ultrasonic, endoscopic periodontal debridement and adjunctive disinfection. If we can produce a biologically acceptable periodontal environ-

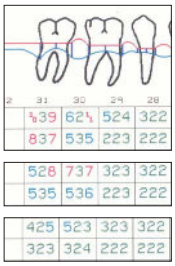

Figure 14. Patient No. 3 initial, six-week and 18-month probings (from top to bottom).

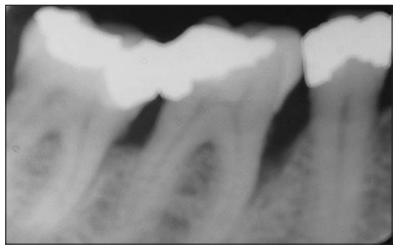

Figure 15a. Patient No. 3 before treatment.

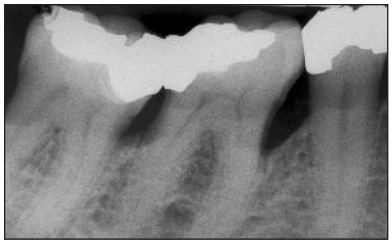

Figure 15b. Patient No. 3, 18 months after treatment.

ment that is below the threshold for an inflammatory response, healing of the soft and hard tissue is possible with treatment that is efficient, minimally invasive and with minimal risk of morbidity.

Conclusion

The introduction of periodontal endoscopy has given dentistry the opportunity to provide a more thorough debridements in a minimally invasive way. This treatment is accelerated by using powered instrumentation, and additional hand instrumentation is generally not necessary. If, however, there is a need to visually modify the root surface using some form of cutting or abrasive instrumentation, there are numerous ultrasonic instruments that are sharp or abrasive to help accomplish such a task in less time, and with less operator effort. In fact, the original ultrasonic instruments were simply modifications of existing hand instruments.[15]

In 1992, Woodall stated: "Ultrasonic instrumentation is now the first choice over hand instrumentation for most patients. This constitutes a major shift in dental hygiene approach to treatment … This text has placed hand instrumentation secondary to ultrasonic instrumentation …"[16] While this tenet is not new, the current level and amount of training available is less than adequate. Just as the types of hand instruments are too numerous to count, the selection of ultrasonic equipment can be confusing. Instruction on their use is widely variable and must be standardized. It is essential for microscopic techniques such as the use of endoscopy and micro ultrasonics be incorporated by our educational system so their potentials can be realized.

Available controlled studies into the value of periodontal endoscopy are limited at this point. However, case series and anecdotal evidence show that this technology has great promise.[17,18] Investment costs and the learning curve are issues that create perceptions, which are limiting the use of the endoscope. Dentistry is just beginning to learn to use this equipment in an effective and efficient way, and is even earlier in the journey into learning how to teach this technology. Micro ultrasonic, endoscopic periodontal debridement will be a major player in the treatment of periodontal disease because it is minimally invasive, highly visual versus tactile, and can be provided by dentists and dental hygienists, in an efficient and effective way. CDA

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Robert E. Horseman, DDS

Über-Celebs and Dentists Get Snippy

If you, Joe or Josephine Doakes, DDS, consider that the most noteworthy thing you've done so far in your life was to wean successfully, the term "clipping service" means little to you.

But to celebrities of every stripe, their clipping service provides the tangible proof they need on a daily basis that their existence and importance in this world is not to be denied.

Every time Madonna's, or Martha Stewart's, name appears in print anywhere in the world, whether it's newspapers, magazines, cereal boxes or milk cartons, a clipping service somewhere busies itself cutting out the reference and assembling the collected verbiage for their client. That's how it's done; you subscribe to the service, it scans printed material looking for your name, then collects and forwards the stuff to you. You can then use it for whatever purpose you like. A bale of clippings can boost your morale, convince somebody who needs convincing that you're the luminary you claim to be, and pad out your resume or paper your bathroom. Genuine celebrities whose names are legend and are mentioned almost daily in a thousand places can probably eschew this ego massaging, but to a wanna-be on the way up, it's heady stuff, a confirmation of their elevation from obscurity.

Clipping services not only cater to individuals, but to groups or categories as well. For example, Eskimos who are into quilt making could undoubtedly subscribe and collect all references to Eskimo quilt making providing the service was paid for in U.S. dollars, not frozen fish. There's even a clipping service for the category of dentists. These dental clips are usually little tidbits useful for inserting at the end of columns where the text of the feature article doesn't quite reach the end of the page. These are enjoyed by people with short attention spans and double-digit IQs. Here are some gleanings from this month's clippings:

Continued on Page 261

Coca-Cola, which has a contract with many of the bears to star in their commercials, refuses to pay for any restorative or even palliative treatment.

Continued from Page 262

Negative Results: Dentist Serge Hiliter of Laverne, Neb., displayed 14,902 dental X-rays he had collected over the years, none of which he could identify. "If you don't put a name on 'em right away," he explained, "after a couple of years they all begin to look the same." Laverne residents were invited to stop by and attempt to pick out their own films. (AP): *If this goes well, patients will be encouraged to find their own charts in his filing system.*

Exodontia, Sexodontia: During the course of his 48-year dental practice in Calcutta, Dr. Krishna Bhatty collected nearly four tons of extracted teeth. These were becoming a serious storage problem until he conceived the idea of suggesting to news media that once ground up into a powder, the teeth had certain medicinal properties, not the least of which was an aphrodisiac. Within 24 hours, the entire lot had been stolen. (Reuters): *It's an ill wind.*

Wait Watchers: Due to a loophole in state law, patients missing five or more appointments in Georgia cannot be prosecuted. This is considered double jeopardy inasmuch as they already are eligible for the death penalty for being more than 15 minutes late for appointments. (UP): *Imagine not responding to a recall card.*

And Nothing But The Tooth: Residents of the vegetarian commune of Nomeat, Alaska, have voted to relax the requirement that law enforcement officers must have at least two opposing teeth to be eligible for employment. Town council members pointed out that since the main diet of the commune consisted of tofu and creamed turnips, anything in excess of one tooth could be considered redundant. (AP): *As long as they can still put the bite on the crooks.*

Armament-Arium: Dentists in Texas, like other citizens there, are now able to carry concealed weapons under new laws. The Texas Dental Association has cautioned members to avoid the words "shot," "shoot," "cartridge," and "automatic" when treating patients. (AP): *Also "stick' 'em up" and "give me your wallet."*

And Dot's Dot: The Eastman Kodak Company of Rochester, N.Y., has been unsuccessful in its attempt to mediate a crisis with its dental X-ray customers. Particularly irate is a growing group throughout the continental United States that insists films should be viewed with the dimple toward the viewer. Equally adamant is a somewhat larger contingent arguing that the dimple be viewed away from the viewer. Eastman's compromise offer to eliminate the dimple altogether pleased neither camp. (UP): *By the way, where are the colored X-rays they promised us?*

Polarization Hard to Bear: Pedodontist Angela Papadailisch of Churchill, Manitoba, has an unusual problem and has appealed to the Canadian Department of Health Services for relief.

Dr. Papadailisch 's shingle plainly states that her practice is limited to children, teenagers, young adults and people. But every year during the annual polar bear migration passing through Churchill to the Hudson Bay, she has a business problem of mean proportions. It seems the bears are continually breaking their teeth while foraging among the garbage cans and Dumpsters on the edge of town.

Animal rights activists have pressured the Churchill dentist to treat these ursine emergencies, but Coca-Cola, which has a contract with many of the bears to star in their commercials, refuses to pay for any restorative or even palliative treatment. The Canadian National Health Plan denies responsibility and the citizens of Churchill refuse to come outdoors to discuss the matter. (Reuters): *Wouldn't you?*

Nader Demands Recall: A study just concluded by Johns Hopkins indicates that teeth are a huge genetic mistake and are on their way out. Evolution will eventually do away with teeth entirely, the study reports, much as human tails have disappeared. Researchers whose investment portfolios were heavily loaded with dental hygiene products have been quietly dumping their holdings except for dental adhesives which are seeing a bull market. (AP): *A word to the wise.* CDA