OF THE CALIFORNIA DENTAL ASSOCIATION

Journal

NOVEMBER 2008

Practical Guidelines

Pretreatment Planning

Interdisciplinary Coordination

Implant Restorations

MICHAEL O. HAMADA, DDS

OF THE CALIFORNIA DENTAL ASSOCIATION
Journal
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DEPARTMENTS

FEATURES

CDA JOURNAL, VOL 36, Nº11

Full Circle

STEVEN A. GOLD, DDS

How does a professional association of 24,000 individuals listen to members' concerns, decide on the best course of action to simultaneously address those concerns and fulfill its professional obligations, and then implement a plan to get results?

Imagine such an organization where all 24,000 individuals have the power to make positive changes in both that organization and their profession. In the business world, this would be unimaginable. In dentistry, and within CDA, it is happening right now.

At the August 2008 CDA Board of Trustees meeting, attendees participated in a discussion called "Knowledge-based Decision Making," an exercise designed to incorporate information and insight into future policy decisions of the association. All meeting attendees, trustees, officers, council and committee chairs, staff, and guests were divided into small groups to facilitate input from everyone.

The highlights of these very lively discussions were then reported back to the group at large and this information will be used to give direction to the association. The process has been used several times over the past few years and allows the association to be actively involved in shaping the future of the profession, not just reacting to events as they happen. It is important to understand this process because it lends credibility to the association's eventual position on the important issues discussed.

So what does this mean for the average member? It demonstrates the power you have in organized dentistry.

And just what are those issues? At this meeting, they were no less than the role of the dentist in the overall health of patients, the scope of dental practice, and the relevance and responsiveness of dental education to emerging dental science and technology. And that was just scratching the surface. The discussion and search for answers began, as often does, with questions. These questions came directly from some of you, the CDA membership. They dealt with the use of botox and sleep apnea appliances in clinical dental settings. Are they legal? Are they appropriate? What role should CDA play in the development of policy around these issues? There is much work to be done in these areas but the discussions that occurred at the August board meeting will serve as a starting place.

So what does this mean for the average member? It demonstrates the power you have in organized dentistry. It shows that reports and questions to CDA from members are, in fact, brought before the association's leadership and discussed in terms of how the dental profession should respond given its many interests and responsibilities. The information will be given to staff where they will apply their expertise in policy development and come back to leadership with recommendations for action. The recommendations will be discussed further by leadership ultimately leading to a decision made by the Board of Trustees.

The issues will subsequently be forwarded to the House of Delegates for final approval. It is a process that begins and ends with the membership of this association and it demonstrates that input from individual members will eventually make its way into action. Because of this, members should continue to voice their professional concerns to the association either through the member contact center or their component's leaders.

For those who want to go a step further, they could become actively involved in leadership and be part of the group that starts the conversation and ultimately makes the decisions. It is a great way to see the flow of ideas come full circle back to the members and to realize the power and responsibility each member has to help shape the practice of dentistry. ■■■■

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

Dan Hubig

Supplement on Inflammation and Overall Health Released

In the last 10 years, research has focused on the role chronic inflammation may play in diseases, including those of the gums. Periodontists have begun to reappraise the current knowledge of chronic disease and inflammation relative to the clinical management of patients with perio problems.

The American Academy of Periodontology held a workshop, "Inflammation and Periodontal Diseases: A Reappraisal," earlier this year. The event, supported through a Colgate grant, brought together more than 80 leading experts in the fields of dentistry, clinical medicine, and basic science.

CONTINUES ON 819

iCEM Self Adhesive

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Heraeus Kulzer, Inc., drives product innovation with the launch of iCEM Self Adhesive. This "intelligent cement" is an all-in-one resin that provides ease and speed of application combined with reliable bond strength. The easy handling and tolerance to moisture on the tooth add to this innovative formula.

For a limited time, Heraeus is offering a special iCEM Introductory Kit that includes 3-7 gm automix syringes, 45 mixing tips, pictorial card and instructions, plus one iCEM Self Adhesive 7 gm syringe refill with 15 mixing tips that are free with purchase. To order iCEM Self Adhesive or to order an introductory kit, go to www.heraeus-kulzer-us.com or call (800) 431-1785.

Complications of Correcting Severe Maxillary Atrophy Reduced by Software

A new study reports that computer software can facilitate surgical planning in patients with severe bone atrophy, according to an article published in the *Journal of Oral Implantology*.

Because of a lack of bone volume and the poor bone quality of the jaw, traditional surgical techniques to correct maxillary atrophy can have greater risks and require longer recovery periods. Successful placement and positioning of implants is paramount to reduce these risks.

In the study, a 66-year-old woman, due to severe maxillary atrophy, was unable to wear her upper and lower complete dentures. Doctors recommended a computerized scan to simulate implant placement in the most appropriate available zones because they felt a computer-guided implant placement was the only way to treat this patient without more complex reconstruction techniques.

The surgery and postoperative care were completed and after three years, the patient rated her satisfaction as 9 out of 10 on a visual analog scale.

Maxillary computerized tomography scans can reduce the risk of surgical complications and improve the postoperative course and functional outcomes by recommending the best possible implant placement and positioning information.

To read the full text of the article, "Computer-guided Implant Placement in a Patient with Severe Atrophy" is available at http://www.allenpress.com/pdf/orim-34-04-04_203_207.pdf.

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Natural Sleep State Can Be Delivered by New Sedative

A patient snoozing happily through a root canal? Is it possible? Yes, according to a new study in *Anesthesia Progress* that shows that intravenous Dexmedetomidine (Dex), which has previously been used as a sedative in intensive care units, may now be appropriate for use by anesthesia-trained professionals. Dex, unlike other anesthesias, produces a state similar to natural sleep. The sedative levels are easily manipulated, it takes effect quickly, respiration and circulation are only minimally altered, and patients are easily aroused to consciousness following the procedure.

Low doses of Dex produce effective sedation, even though patients are easily reawakened after dosing is discontinued, results showed. Patients responded to the sedative within 10 minutes of the start of the infusion and regained orientation within 15 minutes after its discontinuation, with full equilibrium restored in 60 minutes. Discontinuing the Dex infusion about 15 minutes before the end of the procedure is recommended to minimize recovery time. It should also be noted that patients in this study were relatively young and healthy; higher doses and differences in age and health may affect the performance of Dex.

Dex also may be beneficial for patients with high blood pressure or heart disease. Dex, in this study, produced a small but significant decrease in mean arterial blood pressure during the procedure (from 85 mm Hg to 77 mm Hg). In contrast, most local anesthetics used in dentistry contain epinephrine which tends to increase blood pressure temporarily.

To read the entire study, go to http://www.allenpress.com/pdf/ANPR-55-3-82.pdf.

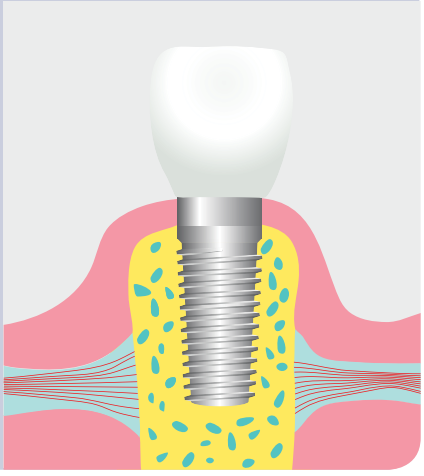
Success Rate High for Dental Implants

Dental implants have a 98 percent success rate and cause little or no bone loss, according to new research published in the *Journal of Oral Implantology*.

Authors Zeev Ormianer, DMD, and Ady Palty, DMD, reviewed 60 charts of patients who received a total of 267 implants in two private dental practices in Israel and Germany and found that 98.5 percent of the implants survived, and there was no discernable bone loss in 88 percent of the implant sites. (The mean follow-up time was 7.5 years.)

The study goal was to determine the level of bone loss over time at the implant sites in the jaw. A key clinical issue was not whether bone loss would occur but how much bone loss should be considered normal and acceptable.

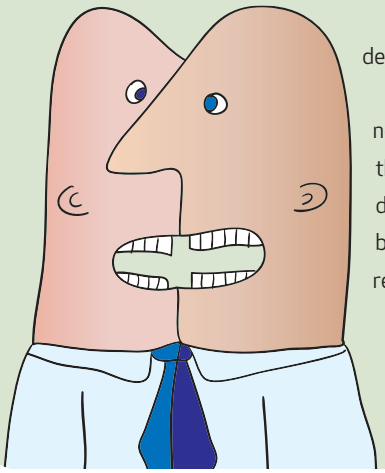
Jamie Lozada, DDS, president of the American Academy of Implant Dentistry, and on faculty with Loma Linda School of Dentistry, said the study adds to growing body of compelling clinical evidence supporting dental implants as the most successful method for replacing missing or compromised teeth. "With an estimated two of three Americans having at least one missing tooth, implants are becoming the preferred tooth-replacement option. Implant surgery is one of the safest, most precise and predictable procedures in dentistry," Lozada said.



Dental Organizations Merge

The American Academy of Dental Group Practice and the Dental Group Management Association, national membership organizations, have announced they will formally merge into a single organization effective Jan. 1, 2009.

In accordance with revised bylaws approved by AADGP members at their last business meeting, the DGMA will form the basis for a new Administrator Section within the AADGP and which will be represented on the AADGP board. Other changes to the bylaws include streamlining the number of AADGP board officers and their terms of office to encourage broader board participation, as well as the creation of a Practice Management Company Membership Section.



AADGP and DGMA together represented the interests of group practice dentists and managers.

In a joint statement issued by the AADGP and DGMA boards, members noted that, "After more than 25 years of collaboration by our two organizations, the merge just makes sense. Dental group practice is distinguished from other delivery settings by the close cooperation and sharing of business decisions by practitioners and managers and it is appropriate that a single organization represent them as well."

AADGP President Alan Slutsky and DGMA President Vincent Cardillo also said "This merge greatly benefits both organizations. Both DGMA and AADGP members are eager to combine efforts and work to support all aspects of the dental industry."

Army Trims Obligation Time for Health Care Officers

The U.S. Army Medical Department has implemented a portion of the Army's Officer Accession Pilot Program that permits it to reduce the Military Service Obligation period to two years for experienced health care professionals ages 43- to 60-years-old, seeking initial appointment as an officer in all Army Medical Department Corps.

This program is extended to dentists, nurses, physicians, veterinarians, and other health care professionals.

Through this new program, qualified health care professionals can now be commissioned as officers in the Army Medical Department for their initial appointment. Upon completion of their two-year service commitment, health care professionals will have no further obligation; however, they may seek to extend their term of service in either active or reserve status should they choose to do so.

"Through this program, the Army is looking to attract highly skilled health care professionals across a variety of fields who want to rediscover their passion for medicine by serving their country and working with one of the best health care teams in the world," said Col. Rafael C. Montagno, Medical Recruiting Brigade commander, U.S. Army Recruiting Command.

To be eligible for service, the volunteer must meet the eligibility criteria, including

- Be a citizen of the United States for Regular Army, or a permanent resident for Army Reserve and able to obtain a secret clearance;
- Be of good moral character; and
- Have completed all educational/specialty licensing and certification requirements in the specific medical field in which the individual seeks appointment as prescribed by The U.S. Army Surgeon General and applicable law, regulation and policy.

For more information about the Officer Accession Pilot Program, go to healthcare.goarmy.com or call (800) USA-ARMY.

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First 'World Oral Health Day' Held

The American Dental Association and the FDI World Dental Federation, in an effort to increase awareness for oral health, as well as the impact of oral diseases on general health and well-being, recently celebrated the first "World Oral Health Day."

According to the U.S. Surgeon General's oral health report, employed adults lose more than 164 million hours of work annually in the United States alone due to dental disease or dental visits.

"The American Dental Association is pleased to stand with the FDI and other national dental associations around the world to emphasize how crucial good oral health is to overall health," stated Mark J. Feldman, DMD, ADA president. "We also want to help increase global awareness about proven preventive measures, including oral health education that can help reduce dental disease and suffering."

Sept. 12 was chosen to coincide with existing oral health days around the world to honor the FDI founder, Dr. Charles Godon, who was born Sept. 12, 1854, and to jointly celebrate the anniversary of the groundbreaking World Health Organization's International Conference on Primary Health Care at Alma Ata, Kazakhstan, which took place Sept. 12, 1978.

"The FDI is delighted to celebrate the first-ever 'World Oral Health Day' with its 191-member associations around the world," said Burton Conrod, DDS, FDI president. "We hope that awareness for the importance of oral health can be elevated through the worldwide recognition of this day. The dentists of the world are committed to helping each and everyone in achieving optimal oral health through prevention and the highest possible standard of care."

Dental Benefits Key to Oral and Overall Health

The National Association of Dental Plans, in a white paper, said dental benefits are integral to overcoming cost concerns that keep Americans from visiting the dentist, a vital step in maintaining oral health.

Based on its consumer survey of more than 6,000 people, the NADP discovered that a lack of insurance is the most common reason for not visiting the dentist — seven times more common than fear. Additionally, those covered by dental benefits have a more positive perception of their oral and overall health.

The survey also revealed that individuals with dental benefits are more likely to receive restorative care to maintain their oral health. They also are more likely to have had a root canal (52 percent); more likely to have had crowns (32 percent); and more likely to have cavities filled (18 percent).

What's more, consumers with dental benefits maintain more of their teeth as they are 30 percent less likely to have a tooth extraction.

On the other hand, respondents without dental coverage are 16 percent more likely to report receiving no basic or major procedures in the last two years.

Based on these findings from the survey, as well as a body of industry research and studies, the NADP released a white paper "Den-Benefits: A Wise Investment in Your Family's Health," which explores the prevalence of dental disease in children and adults and the role of dental benefits coverage in maintaining oral health. The paper also provides general information about the cost of dental benefits, reasons to have dental coverage, and where to find it.

To obtain a copy of the white paper, go to NADP's consumer Web site, ineeddentalbenefits.com.

Honors

Cindy Lyon, DDS, Murphys, Calif., has been named chair of the Department of Dental Practice at the Arthur A. Dugoni School of Dentistry. She will manage the educational curriculum; recruit, mentor and monitor faculty and staff members; maintain relations with Dugoni's administration; represent the department in forming academic policy; and serve on a variety of committees, including the Dental Faculty Council and the Executive Admissions Committee.

Earlier this year, Omicron Kappa Upsilon honored Lyon with the Charles Craig Teaching Award, which recognizes educators who have implemented innovative teaching techniques in dental education. She is the recipient of the California Dental Association Distinguished Service Award, and is a fellow of both the ADEA Leadership Institute and the Pierre Fauchard Academy.

Nader Nadershahi, DDS, MBA, San Rafael, Calif., has been appointed as associate dean for Academic Affairs at the Arthur A. Dugoni School of Dentistry.

Cindy Lyon, DDS

Nader Nadershahi, DDS, MBA

Kirk M. Hobock, DDS, MAGD, of San Juan Capistrano, Calif.; **Christopher H. Kleber, DDS, MAGD**, of Coronado, Calif.; and **Chikka M. Raju, DMD, MAGD, ABGD,** of Norco, Calif.; were recently presented with the Academy of General Dentistry's Lifelong Learning and Service Recognition Awards.

The honors acknowledge the continued achievements of AGD masters "who clearly recognize the professional obligation to remain current in their profession. Active members create an example that reminds each member of the dental profession to never lose sight of this obligation."

INFLAMMATION, CONTINUED FROM 815

Workshop proceedings were published in a special supplement to the August issue of the *Journal of Periodontology* and the workshop planning committee presented the published findings at the American Dental Association's annual session last month in San Antonio.

"The purpose of making the workshop proceedings available to the dental, medical, and other scientific communities is to expand awareness and understanding of inflammation as a common factor in many diseases, including periodontal disease," said Kenneth Kornman, DDS, PhD, editor of the *Journal of Periodontology* and a member of the workshop on Inflammation Planning Committee. "Furthering our understanding of inflammation will allow all health care professionals to better treat their patients."

The *Journal of Periodontology's* supplement included commentary and summaries based on the workshop's presentations from leading researchers and clinicians discussing the role of inflammation in disease and what this role might mean in the prevention, diagnosis, and treatment of various diseases, including perio disease. Topics such as genetic and environmental factors that regulate inflammation, why inflammation is different among different individuals, and the role of inflammation in diseases such as periodontal disease, diabetes, Alzheimer's disease, and cardiovascular disease, also were covered.

For information on receiving an electronic copy of *"Inflammation and Periodontal Diseases: A Reappraisal"* contact the AAP's Public Affairs Department, (312) 573-3242.

Spellex

Spellex announced the release of their medical and pharmaceutical spelling dictionaries that are now compatible with Adobe programs. Spellex Medical 2008 and Spellex Pharmaceutical 2008 now offer correct spelling for more than 300,000 medical words and thousands of drug and prescription pharmaceuticals, generic drugs, Latin and Greek terms, distributors and manufacturers, and more.

Medical dictionary users can also subscribe to Spell-X-Plus software for quarterly updates of new terms, medications, etc. Prices start at $99 for single users and $595 for 10 user licenses. For more information, go to www.spellex.com or call (800) 442.9673.

Baby Firefly Step 1 Toothbrush by Dr. Fresh

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Baby's first tooth will make its debut between four and seven months of age. Dr. Fresh has designed a colorful toothbrush that will set the stage for good oral care habits and healthy smiles. Built-in LCD lights flash brightly for the proper length of time that each arch should be brushed, as well as keeping baby happy and interested. Soft nylon bristles are gentle on the gums and teeth, and the toothbrush's shape fits baby's small mouth. Baby Firefly toothbrushes are available in pink or blue and retail for $2.69 each.

Strengthen Medicaid Oral Health Programs

The American Dental Association recently called on Congress and other stakeholders to work together to get more dentists to participate in Medicaid and help the program provide necessary dental care to vulnerable low-income children.

In testimony provided to the House Committee on Oversight and Government Reform Subcommittee on Domestic Policy, ADA Vice President Jane Grover, DDS, said the most effective thing Congress and the states can do to help Medicaid provide quality oral health care is to increase reimbursement rates to attract more dentists into the program. In addition, they should address ongoing administrative barriers (such as excessive paperwork), and involve state dental societies and individual dentists as active partners in improving the program.

As dental director at a federally qualified health center in Michigan, Grover said she is well acquainted with the reasons many private practice dentists do not participate in Medicaid. Many state Medicaid fees, she noted, are well below what it costs dentists to provide care, a situation that severely limits the program's effectiveness.

Grover cited Michigan's "Healthy Kids Dental" program for its effectiveness in improving access to oral health care.

"The 'Healthy Kids Dental' program is essentially the same as the private sector Delta Dental plan used by many individuals with coverage provided by their employer in the state of Michigan," she said. "The dentists are paid at a PPO rate, which might be less than the usual rate charged by the dentist but is still widely accepted. The claims processing is identical to the private sector plan, except the beneficiaries have no co-pays and there is no annual maximum."

To help states improve their Medicaid programs and greatly improve dental coverage for low-income children, Congress should pass HR 2472, the Essential Oral Health Care Act, Grover said.

Handpiece Experts/ Sirona Dental Systems

Handpiece Experts and Sirona Dental Systems has launched the new Air Power and E-Power handpieces series. These handpieces are lightweight, high-performance, durable, and optic equipped. The handpieces are available throughout North America through certified Handpiece Experts dealers. For more information go to www.handpieceexperts.com or www.sirona.com.

UPCOMING MEETINGS

2008	
Nov. 2-8	United States Dental Tennis Association fall meeting, Palm Desert, dentaltennis.org.
Nov. 13-15	Hispanic Dental Association's 16th annual meeting, Carefree, Ariz, hdassoc.org.
2009	
May 14-17	*CDA Presents The Art and Science of Dentistry,* Anaheim, 800-CDA-SMILE (232-7645), cda.org.
Sept. 12-13	*CDA Presents The Art and Science of Dentistry,* San Francisco, 800-CDA-SMILE (232-7645), cda.org.
Oct. 1-4	American Dental Association 150th Annual Session, Honolulu, Hawaii, ada.org.
Nov. 8-14	United States Dental Tennis Association fall meeting, Scottsdale, Ariz., dentaltennis.org.

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

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THE SINGLE-TOOTH DENTAL Implant Restoration

MICHAEL O. HAMADA, DDS

GUEST EDITOR

Michael O. Hamada, DDS, is an assistant researcher and consultant in the Division of Advanced Prosthodontics, Biomaterials and Hospital Dentistry, University of California, Los Angeles, School of Dentistry. He maintains a private practice limited to prosthodontics and maxillofacial prosthetics in Santa Monica, Calif.

Tremendous advances have been made in the area of dental endosseous implantology in the decades following the introduction of the concept of "osseointegration" by Professor Per-Ingvar Brånemark based upon his research with vital microscopic studies in situ of bone marrow beginning in 1952. Improvements in dental implant design and surface technologies, and advancements in clinical techniques and materials reflect an ever-increasing understanding of the biologic parameters that influence the peri-implant environment and determine the success and predictability of this "direct structural and functional connection between ordered, living bone and the surface of a load-carrying implant."[1] Our increasing knowledge base and experience with dental implants has been accompanied by a broadening in the scope of their application.

Whereas early applications beginning in 1965 were limited to the completely edentulous arch, restoration of partially edentulous span, including replacement of single missing teeth with dental implants has become common and well accepted, with predictably high success rates with regard to functional criteria.

Like many of our patients, some practitioners may expect the replacement of a missing single tooth in the esthetic zone with a dental implant restoration to be a particularly simple matter. Twenty years ago, when the majority of dentists in the United States had not yet had experience with dental implants, participants in my dental implantology courses would routinely assume that the easiest cases with which to begin their dental implant experience was the restoration of a missing single tooth. After all, shouldn't it be a relatively simple matter to replace a single anterior tooth, compared to the complexity of restoring multiple missing posterior teeth or an edentulous arch? Today, those practitioners with more extensive experience probably know this assumption to be "somewhat" inaccurate.

As in other areas of dentistry, a paradigm shift accompanying advances in dental implant technology has occurred. Patient expectations and demands for natural-appearing restorations have driven a shift from merely restoring function, to restoring or establishing pleasing cosmetics, with increasingly stringent esthetic criteria. Given the pervasive marketing of appearance-related dental products and procedures direct to the consumer, it is no wonder that our patient's expectations with regard to a single-tooth dental implant replacement can be so demanding, particularly in the esthetic zone. Fair or not, it is understandable that our patients frequently define "failure" as "whenever my personal treatment expectations are not fulfilled."

For these reasons, a detailed understanding of the multidisciplinary parameters determining the restoration of normal tooth and peri-implant hard and soft tissue form and contour, esthetics, speech, function, and health is necessary to have the best chance of successfully fulfilling our patient's expectations, and those of our own, in a predictable fashion with regard to not only esthetics, but also function, longev-

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ity, length of treatment time, number, and nature of procedures and cost.

In this issue, a multidisciplinary approach to planning and treatment for the single-tooth dental implant restoration will be presented. Success is facilitated when all members of the team – implant surgeon, restorative dentist, orthodontist, dental laboratory technician, and patient – are familiar with each others roles, the basic principles underlying what each specialty can contribute to treatment, and how to best coordinate everyone's efforts.

Dr. Kumar Shah presents a step-by-step guide to the pretreatment restorative evaluation appointment and outlines clinical, historical, and radiographic diagnostic data critical for determining the appropriate sequencing and selection of implant surgical and adjunctive procedures. In addition, he discusses the various factors that make dental implant treatment restoratively driven but surgically and orthodontically facilitated.

Dr. Michael Lum provides insight into the organizational process involved in treatment planning, facilitating communication among team members, and coordination of procedures and appointments.

Dr. Doina Panaite, Dr. Perry Klokkevold, and Dr. Allan Charles describe the peri-implant biologic parameters that influence the presence and contour of the peri-implant papilla and review implant selection characteristics, soft tissue management techniques and emergence profile factors affecting papilla preservation and reformation. Importantly, they provide us with information needed to reasonably predict expected final soft tissue contours prior to initiation of treatment.

Finally, Dr. Moustafa El-Ghareeb, Dr. Tara Aghaloo, and Dr. Peter Moy address various postextraction hard tissue management and augmentation options available to preserve or create a more ideal implant site and elucidate parameters determining the indications and predictability of each.

The authors hope that you enjoy this issue and find it to be a useful guide to help navigate your way through the myriad of considerations, treatment options, communication and coordination necessary to consistently predict treatment outcomes and successfully meet patient expectations when restoring a missing tooth with the single-tooth dental implant restoration. ■■■■

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1. Brånemark PI, Zarb GA, Abrektsson T, Tissue-integrated Prostheses: Osseointegration in Clinical Dentistry, Quintessence Publishing Co., Chicago, Ill., 1985.

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Treatment Planning for the Single-tooth Implant Restoration — General Considerations and the Pretreatment Evaluation

KUMAR C. SHAH, BDS, MS, AND MICHAEL G. LUM, DDS

ABSTRACT This article reviews relevant clinical and radiographic information necessary to formulate an appropriate treatment plan for a patient requiring a single-tooth implant restoration. A step-by-step approach to collecting and analyzing this information at the pretreatment evaluation is presented. General considerations affecting implant treatment planning are discussed as are the parameters dictating ideal implant position and angulation.

AUTHORS

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Several criteria must be met for the successful restoration of a missing single tooth with a dental implant restoration. Understanding how the patient's pretreatment presentation impacts the method of how, and to what degree, these criteria may be met, is critical to formulating an appropriate treatment plan and improves one's ability to restore natural esthetics, function, long-term health, and patient comfort. The purpose of this article is to present a step-by-step approach to collecting relevant clinical and radiographic information necessary to formulate an appropriate treatment plan for a patient with a missing single tooth. The Pretreatment Evaluation Form (**TABLE 1**) may be utilized to document clinical and radiographic findings that determine the need for adjunctive procedures and treatment prognosis.

Pretreatment Evaluation Appointment

Determining the Patient's Perspective

When a patient presents with a chief complaint that requires a single tooth replacement, the first step in the authors' evaluation process is to determine their preferences and expectations for treatment. Potential treatment options for replacement of a missing single tooth may include a single-tooth dental implant restoration, a three-unit fixed dental prosthesis, a removable partial denture, or a resin-bonded

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prosthesis.[1] Each option has advantages and disadvantages that may or may not meet the patient's expectations for treatment. A brief discussion of these advantages and disadvantages will help the patient determine those potential options to which they are amenable.

A single-unit implant may eliminate the need for adjacent tooth preparation, unlike a three-unit fixed dental prosthesis. On the other hand, dental implant treatment involves surgical procedures that the patient may not be agreeable to, or be able to undergo, due to medical health or other concerns. Although it is generally one of the least expensive treatment options, the patient may not wish to wear a single-unit removable partial denture due to the potential infringement of the major connector upon speech and masticatory enjoyment. Once the patient has made an informed decision to explore the dental implant option, the next step is to determine if the patient is a candidate for dental implant treatment.

Patient Evaluation

Systemic Evaluation

A number of factors may determine whether a patient presenting with a missing single tooth is a candidate for a single-implant restoration. Systemic contraindications to dental implant therapy are well documented.[2,3] While there are no true absolute contraindications to dental implant treatment that have been reported, diabetes, heavy smoking, history of radiation therapy, chemotherapy, and any other condition that may compromise the immune response may be considered relative contraindications.[2] Patients with such pre-existing condition should be treated with caution and be made aware of the potential guarded prognosis.[2]

Clinical Exam

Esthetic and Smile Analysis

Although it is beyond the scope of this article to fully elucidate the myriad considerations involved in dental esthetics and smile analysis, it should be noted that patients may vary widely in their level of esthetic demands and expectations. While failure to meet certain esthetic expectations may result in varying degrees of patient disappointment, failure to meet patient demands can be more problematic. These demands and expectations may not be limited to areas of tooth and gingival exposure when smiling, or areas exposed during normal speech and function. In other words, rather than being limited to the zone of visible teeth or gingiva, it is worth noting that "the esthetic zone is what the patient thinks it is."

A SINGLE-UNIT IMPLANT may eliminate the need for adjacent tooth preparation, unlike a three-unit fixed dental prosthesis.

In order to determine whether the patient's pretreatment physical presentation meets, or can be modified to meet, dental and gingival contours acceptable to the patient (whether visible under normal function or not), it is important to carefully document the patient's esthetic expectations and demands in detail. Documentation may include the degree of acceptance of asymmetries or discrepancies in 1) gingival balance; 2) papilla morphology; 3) root eminences; 4) gingival color and texture; 5) tooth morphology; and 6) tooth shade. Various biologic parameters such as those determining peri-implant soft tissue contours are then evaluated to determine whether absolute patient demands can be met and to what degree patient expectations can be fulfilled.

Photographic imaging and analysis

Digital photographs serve not only as a record of the patient's pretreatment condition but also facilitate diagnosis and treatment planning. In conjunction with diagnostic study casts, digital photographs facilitate making more accurate and convenient measurements of dental and gingival contours than may be made intraorally at the time of the pretreatment evaluation appointment.

An esthetics evaluation and documentation would generally include the following photographs: 1) facial views, both frontal and profile; 2) lips at a relaxed position; 3) natural smile view; 4) most extended lip position (like when pronouncing the letter "E"); 5) frontal and lateral views of the teeth with the cheeks retracted; 6) occlusal views of each arch, taken with an intraoral mirror; 7) teeth in protrusive and lateral excursive positions; and 8) regional occlusal, frontal, and lateral views of the edentulous area highlighting residual ridge contours.

Utilizing a graphic arts computer program, or simply a pen and ruler on a digital print, several reference lines can be drawn to illustrate asymmetries between the single-unit edentulous span and the dentate contralateral side. Occlusal views of the edentulous area may be compared with the contralateral root eminence to help determine the buccal extent of any contour deficit. In the frontal view, the height of each papilla is marked, as is the location of each interproximal contact. In addition, the height of the residual ridge crest is compared with the marginal gingival contour of the contralateral tooth.

FIGURE 1. Comparison of edentulous span dimensions with corresponding contralateral tooth dimension. The purple arrow indicates the excess space that is present as the black arrows are of the same length. Green arrow indicates the height of the contralateral tooth and relates it to the edentulous span.

FIGURE 2A. Thick gingival biotype with a less scalloped (flat) gingival architecture. Note the square tooth form.

FIGURE 2B. Moderately thin and scalloped gingival biotype. Note a more triangular tooth form.

FIGURE 3. Use of a periodontal probe to clinically assess the buccal contour of the residual ridge. Note lack of labial root prominence.

FIGURE 4A. Measurements made on a periapical radiograph (yellow: crestal bone contour; green: crestal bone to interproximal contact area; red: inter-radicular space available at ridge crest and apex.)

FIGURE 4B. Clinical photograph digitally superimposed on periapical radiograph illustrating hard and soft tissue relationships used to predict esthetic results.

In conjunction with periapical radiographs to determine underlying interproximal and crestal bone height, these pretreatment photographs may be utilized to predict post-treatment soft tissue contours by applying biologic principles and measurements dictating papilla and marginal gingival contours. Either a digitally manipulated image of the expected results, or a simple hand-drawn overlay over the pretreatment image may be produced for the patient to illustrate any potential asymmetries with the contralateral periodontium, such as the presence or absence of "black triangle disease" or any tooth length discrepancies.

Diagnostic Study Casts

Study casts are essential to collect and analyze clinical information for the treatment planning process. If study casts are available at the clinical exam visit, the smile line and amount of tooth display as previously discussed, may be transferred to the casts. A periodontal probe can be used to measure the distance from a specific landmark, such as the incisal edges and transfer the markings onto the casts. When multiple points are transferred, a connecting line can be drawn to indicate the overall lip curtain. The other dimensions that will be discussed subsequently can also be measured from a set of mounted diagnostic casts. As described in more detail later, study casts are also utilized to fabricate radiographic and surgical templates to help facilitate communication and coordination of treatment between surgical and restorative implant team members.

Adjacent Tooth Contour and Effect on Gingival Embrasure

The adjacent tooth contours play an important role in developing proper esthetics, contours of the final restorations, proper embrasures, and soft tissue architecture.[4] They should be assessed in terms of their size, shape (form), and color.[4] The size of the edentulous space should closely resemble its corresponding tooth on the contralateral side (FIGURE 1). Minor discrepancies may be adjusted by changing the contours and line angles of the restoration in the anterior zone. In moderate to severe cases, orthodontic tooth movement or other restorative procedures may be planned to distribute the spaces evenly.[5,6]

Teeth may be broadly classified into a square, ovoid, or triangular tooth form.[4] The longer and broader contact area between teeth that exhibit a square form facilitates masking of a deficient papilla (FIGURE 2). On the other hand, the more triangular tooth form tends to have a narrower contact point, which is usually away from the gingival crest. This increases the risk of an unesthetic dark space (aka black triangle disease) interproximally.[4]

For the anterior single-tooth implant restoration, of particular importance is the anatomy of the cingulae of contralateral anterior tooth. Making the cingulum contour of the single-implant restoration consistent with the natural lingual anatomy of the adjacent teeth minimizes the potential for phonetic difficulties and a "curious" tongue. While prominent natural cingulum contours may provide more "leeway" with regard to space for restorative material, patients presenting

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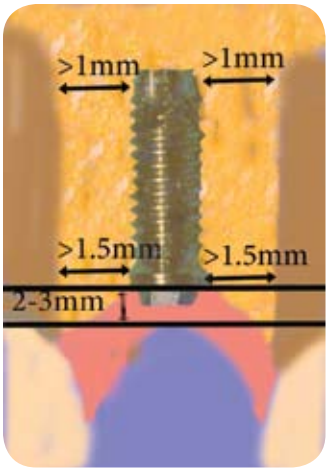

FIGURE 5A.

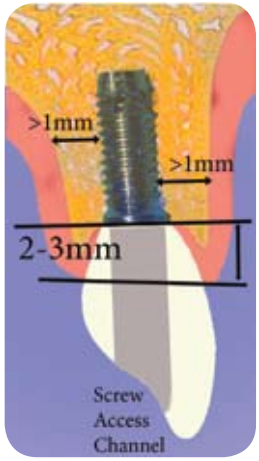

FIGURE 5B.

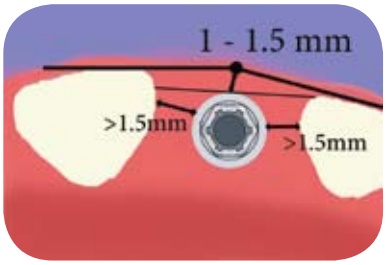

FIGURE 5C.

FIGURES 5A-C. Ideal 3-D implant placement. 1) 2-3 mm apical to the cementoenamel junction (CEJ); 2) 1-1.5 mm palatal to the proposed buccal contour of the tooth; 3) minimum of 1.5 mm of interproximal bone at the ridge crest; 4) minimum of 1.5 mm of bone bucally; 5) minimum of 1.0 mm of clearance at the radicular apex; 6) axial angulation commensurate with screw access opening in a nonesthetic tooth surface.

with minimal lingual contours provide little room for error, particularly in the case of a screw-retained prosthesis. This places an added responsibility on the restorative dentist and the laboratory technician to precisely dictate implant position and angulation via the surgical/radiographic template, and on the implant surgeon to precisely place the implant fixture.

In addition to the adjacent teeth, the residual ridge can also be clinically assessed at this point, as shown in **FIGURE 3**. A periodontal probe can be placed at the buccal height of contour of the adjacent teeth and the edentulous site is visually assessed. This may provide additional information to determine if additional bone grafting procedures are needed. This will be addressed in the subsequent article on hard tissue augmentation.

Adjacent teeth with overcontoured restorations or teeth that are mesially drifted or angled, those that are periodontally compromised and are already lacking a papilla may require a preprosthetic procedure prior to the implant placement. Orthodontic treatment may be a useful adjunctive procedure.[7] The location of the contact area on adjacent teeth may also need an adjustment prior to fabricating the final restoration. Teeth with contact areas that are located too coronally may require reshaping in order to prevent excessive gingival embrasures from appearing, or to achieve greater symmetry between contralateral papilla heights.

Soft Tissue Contour Assessment

Both the quality and quantity of soft tissue architecture should be noted in addition to the periodontal probing depths. The information to note would include: 1) the thickness of fibrous connective tissue; 2) the amount of attached tissue; 3) the amount of keratinized tissue; and 4) the degree and symmetry of the gingival scallop.

Thick and fibrous gingival biotype are considered more resistant to recession and generally result in a more predictable and stable outcome, as opposed to a thin biotype.[8] In addition, an adequate collar of keratinized tissue surrounding the implant restoration provides a healthy emergence, suitable to resist trauma from mastication, oral hygiene measures and allows for a prosthetic procedures more conveniently.[9]

The scallop of the gingival architecture would also be important to note.[4] The highly scalloped gingival would lend itself to be a more complex situation to maintain as opposed to the flat gingival contours as shown in **FIGURE 2**. This usually corresponds to the tooth form where the triangular form usually has a more scalloped gingival contour and vice versa.[8] The digital photographs can be used at this stage to mark the height (zenith) of the gingival contour with a straight line (**FIGURE 1**) so as to plan for the ideal apicocoronal position for the implant fixture.

The degree of papilla preservation can be predicted by the height of the adjacent bone when a single edentulous site is bounded by natural dentition. A distance of 5 mm from the interproximal crest of the adjacent teeth to the interproximal tooth contact point has been shown to maintain the papilla predictably.[10] This position is dictated by the interproximal bone level of the adjacent teeth rather than that of the implant site. When multiple teeth are missing in an edentulous site, papilla regeneration becomes more difficult and less predictable.[11] An in-depth discussion on the parameters and predictability of papilla preservation and reconstruction is presented in the following article on soft tissue procedures.

Radiographs

A full-mouth series of periapical and a panoramic radiograph are a good initial tool for determining the overall quantity of the bone. Root spacing and angulations

are adequately observed on the periapicals or panoramic radiographs (**FIGURES 2–6**). The crestal bone levels can be traced and connected (yellow line). The height from this crestal bone level and the anticipated interproximal tooth contact can be measured from the radiographs as well (green line) in order to calculate expected interdental papilla contours. Roots that are converging toward the edentulous space may create a surgical implant placement problem and so measuring this space, both at a crestal and apical position (red arrows) would aid in selecting the appropriate diameter of the dental implant.

However being a 2-D film, conventional radiographs do not provide an indication of the buccal lingual width of the edentulous site. A 3-D scan, like a tomogram or a cone-beam CT scan may be indicated at times. Previously, practitioners had mapped or sounded the bone to get an idea of the width of bone. The site was anesthetized and soft tissue is mapped with a periodontal probe or an explorer with an endodontic stopper. The thickness of the soft tissue is measured at multiple sites from the buccal to the lingual vestibule. This process may be quick but is also a little inconvenient and uncomfortable for the patient. The CT scans are generally more accurate and are also able to determine the quality of the bone by providing a density value. Moreover, there are several implant planning software programs that allow 3-D digital surgical planning utilizing CT data in order to anticipate whether the implant can be place ideally or if any adjunctive graft procedure may be needed. These scans are best done with a radiographic guide in place in order to obtain the location of an ideally contoured restoration and its relationship to the amount of bone available. If orthodontic treatment is anticipated, the periapicals and the panoramic radiographs are generally sufficient initially. At the completion of orthodontic treatment, a CT scan may be performed for more diagnostic information, prior to implant placement.

FIGURE 6. Sequence of pretreatment planning. Note the difference in the angulation of the proposed channel in the guide and the residual ridge. In this case, a decision had to be made to change the angulation of the implant or perform additional grafting procedure prior to placing an implant.

Ideal Implant Positioning
(REFER TO FIGURES 5A–C)

Spacing Requirements

As a general guideline, for a typical 4 mm regular platform implant, a 7 mm mesial-distal space between adjacent teeth at the coronal portion is the minimal requirement. This allows for 1.5 mm of crestal bone interproximally, which, in turn, will allow for proper development of a healthy papilla.[12,13,4] An article on soft tissue procedures, included in this issue, will discuss how the concept of "biologic width" is applied to the soft tissue around an implant restoration. Apically, 6 mm between adjacent roots is recommended, to allow at least 1 mm space from the implant to the root. These guidelines generally allow for adequate blood supply to maintain the interproximal bone.

Implant Bodily Position

Occlusal-gingivally, the vertical position of the implant is determined by the level of cementoenamel junction of the proposed restoration at the edentulous site. The implant should be placed just deep enough to allow for a proper emergence profile but not excessively deep as to cause a periodontal maintenance issue.[12] Ideally implants should be placed 2-3 mm apical to the facial CEJ position of the planned final restoration, not the adjacent teeth. With regard to length of the implant, ideally it should be in the range between 10 to 13 mm. A shorter implant may be more prone to occlusal overload while implants longer than 13 mm do not necessarily improve the biomechanics.[14]

Facial-lingually, a minimum of 1 mm of bone present on either side of the implant may help keep the soft tissue levels stable. This may be more crucial on the facial aspect since any changes in bone resorption will esthetically affect the position of the gingival margin.[15] As a precaution, a 0.5 mm palatal shift in implant position is often elected for having about 1.5 mm of buccal bone remaining. This will also allow a more favorable screw access hole through the cingulum of an anterior tooth and may reduce the need to correct for angulations issues.

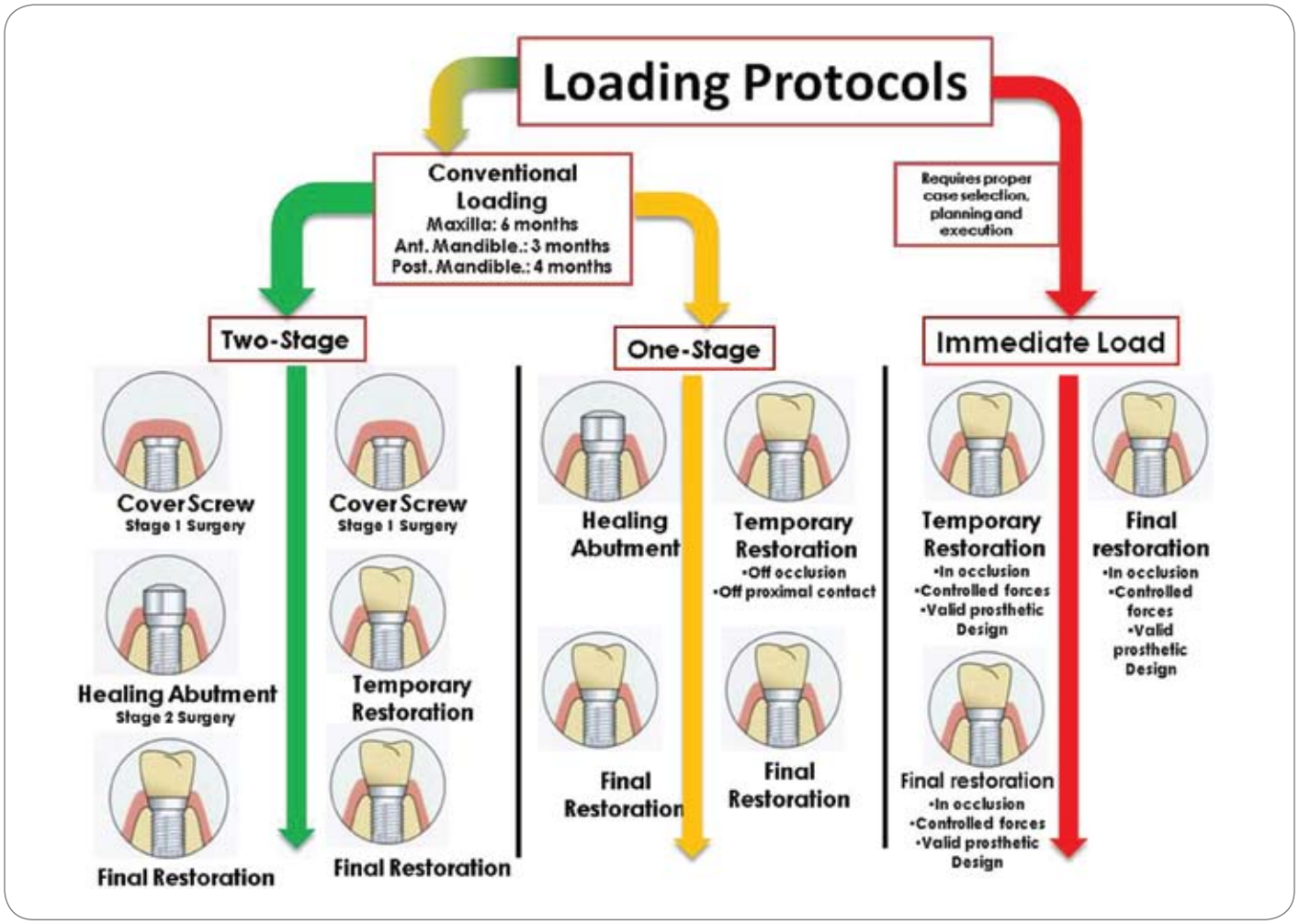

FIGURE 7. The various loading protocols for an implant replacing a single missing tooth.

Angulation

Implant angulation should be determined by the ideal contours of the final restoration. Occlusal forces are best tolerated when they are directed down the long axis of the dental implant fixture. Maxillary anterior implants would have a slight proclination while maxillary posterior implants may be angled slightly toward the buccal. Mandibular posterior implants may be angulated slightly lingual following the resorption pattern and direction of masticatory forces (Curve of Spee and Wilson). If there is insufficient bone, grafting procedures should be done and an attempt be made to position the implant in a more favorable angulation thereafter.

Diagnostic Work-up

A set of mounted cast and diagnostic work-ups are useful in the dental implant treatment planning process. **FIGURE 6** indicates the sequence of this planning process. A idealized diagnostic wax-up is done to mimic final restorative contours regardless of underlying bony or soft tissue deficiencies. The laboratory technician would then duplicate it and fabricate a radiographic/surgical guide or template. There are a variety of methods of fabricating a radiographic/surgical guide.[16] A rigid vacuum-formed stent may be formed over a duplicate of the diagnostic wax-up in order to duplicate the missing tooth and to provide a means to consistently orient the guide intraorally. A radiopaque material such as barium sulfate is mixed with acrylic/composite resin and used to fill in the missing tooth in the stent.

Alternatively, the radiopaque mix can be utilized to form a denture "tooth" and then oriented with an occlusal index of clear autopolymerizing acrylic resin. Either way, a channel is drilled through the center of the radiopaque "tooth" indicating the ideal implant position and angulation (**FIGURE 6**). An alternate method of fabricating the surgical guide is to fill the tooth mold with regular acrylic/composite resin. The channel is prepared similar to the first method but is filled with gutta percha as a radiopaque marker. In addition, the buccal surface of the tooth is lined with tin foil. The radiopaque tin foil appears as an outline in the

TABLE 1

Implant Pretreatment Evaluation

Patient _____ Date _____

Chief Concern _____

Significant Medical History / Meds / Allergies _____

Edentulous region _____ (tooth number to be replaced)

Smoking	☐ No	☐ Yes	_____ (quantity)
Alcohol	☐ No	☐ Yes	_____ (quantity)
Parafunctional habits			
Bruxing/Clenching	☐ No	☐ Yes	_____ (frequency)
Smile line	☐ Low	☐ Average	☐ High
Occlusal scheme	☐ Anterior guidance	☐ Group function	☐ Posterior interferences
Adjacent tooth/crown form	☐ Square (contact area)	☐ Ovoid	☐ Triangular (contact point)
Hard tissue			
Horizontal deficiency	☐ No	☐ Yes	_____ (quantity)
Vertical deficiency	☐ No	☐ Yes	_____ (quantity)
Soft tissue			
Gingival biotype	☐ Thick/fibrous	☐ Average	☐ Thin
Gingival contour	☐ Flat	☐ Average	☐ Scalloped
Presence of attached tissue	☐ Yes	☐ No	
Presence of keratinized tissue	☐ Yes	☐ No	
Radiographic exam			
Adjacent root angulation	☐ Divergent	☐ Parallel	☐ Convergent
Mesial-distal space at crest		_____ mm	(≥7 mm ; <7 mm)
Mesial-distal space at apical end/root tip		_____ mm	(≥5 mm ; <5 mm)

Distance from adjacent crestal bone to contact point (mesial to space) _____ mm

Distance from adjacent crestal bone to contact point (distal to space) _____ mm

(<5 mm ; between 5-7 mm ; >7 mm)

Overall prognosis ☐ Good ☐ Fair ☐ Guarded

scans indicating the buccal contour of the tooth and its relation to the residual ridge.

These guides are relatively inexpensive to fabricate in comparison to the overall treatment cost and are critical not only to assess and plan the proposed implant position but to accurately relate the radiographic image to the actual site at the time of surgery. Following their use as a radiographic guide, the guides are sterilized for use as surgical templates. They should be free from debris, loose particles, or burs that may dislodge and contaminate the surgical site.

A number of software packages allow CT data to be utilized for computer-aided implant surgical planning by means of virtual surgeries on modeled 3-D images. Some of these programs incorporate the ability to generate surgical guides via CAD/CAM technology. These guides are made with computer-machined channels that limit the site preparation to the precise implant angulation, bodily position, and depth determined during the software planning phase. While these technologies may promise greater potential precision in implant placement, at this time, there may be some added costs to these types of guides particularly for the single-tooth application in comparison with manually produced guides.

Occlusion

It is important to understand what factors may affect the anticipated load the implant restoration must resist. Implants generally perform better in axial load as opposed to lateral loads.[17] In the anterior maxilla, lateral loads are unavoidable due to the vertical and horizontal overlap of the anterior teeth. The relationship of the opposing dentition plays a vital role in the long-term success of the restored implant. The amount of interarch space (crown-height space) available should also be noted as it may impact treatment planning decisions.[18,19] Dentitions with good stable bilateral simultaneous contacts in centric relation or maximum intercuspal position would allow a light centric contact on the implant restoration with minimal risk of implant overload.

The type of occlusal scheme the patient presents with should be noted. Favorable occlusal schemes would include those that have good, immediate anterior guidance.[20] This could help avoid excessive lateral loads on a posterior implant, for example. Ideally, the implant restoration should not change the existing occlusal scheme.

Patients who exhibit parafunctional habits are not contraindicated from having an implant restoration. Although no controlled definitive clinical outcomes studies exist, some practitioners have suggested that occlusion has to be carefully analyzed and the restoration adjusted to have narrower occlusal tables to minimize implant overload or fracture.[21,22] If space permits, like in the molar regions, some practitioners have placed two smaller diameter implants for a single-tooth restoration to increase the bone/implant interface in an attempt to achieve more favorable stress distribution and resistance to overloading.[22] **FIGURE 7** illustrates the various loading protocols for an implant replacing a single missing tooth.

Summary

The initial steps of a new patient evaluation and factors to consider for treatment planning a single-tooth implant restoration have been presented. ■■■■

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A Multidisciplinary Approach to Treatment Planning the Single-implant Restoration: Interdisciplinary Coordination

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ABSTRACT The purpose of this article is to delineate the sequential thought process involved in a multidisciplinary approach to treatment planning the single-implant restoration. The pertinent issues involving orthodontic, surgical and restorative processes will be discussed comprehensively, with an emphasis on how communication and coordination among specialists influence the manner in which treatment is rendered.

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As the primary care provider for the patient, it is the responsibility of the restorative dentist to serve as a "team leader," coordinating and integrating the efforts of the various specialists involved in the treatment.[1] Team members include not only the patient, restorative dentist, and implant surgeon, but also the dental laboratory technician and orthodontist. The purpose of this article is to discuss various treatment planning considerations and their impact on formulating a multidisciplinary treatment plan, and to describe how to facilitate communication and coordinate treatment among various team members.

Having input from the restorative dentist to determine the final implant position greatly benefits both surgeon and patient. Likewise, the laboratory technician who appreciates various surgical and biological considerations can better avoid potential problems. For example, an adjacent tooth may present with a favorable crown position but with an unfavorable root angulation interfering with the potential implant site. Relying solely on the cast, without an understanding of the surgical and biologic requirements for successful implant placement, this problem may remain undiagnosed by the laboratory technician, resulting in an improper or unusable implant

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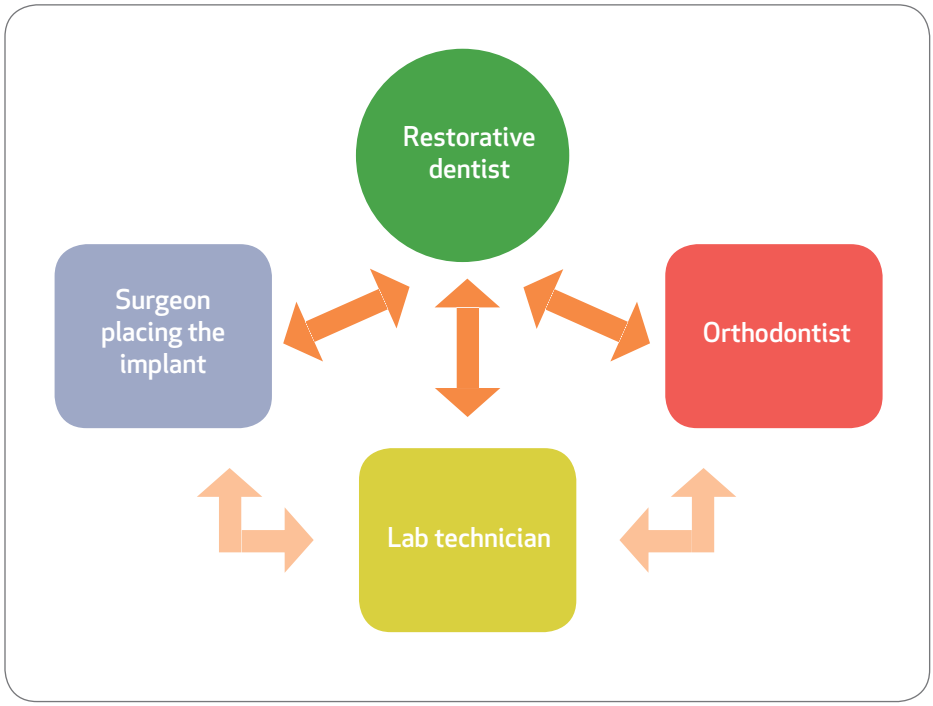

TABLE 1.

angulation in the surgical/radiographic template. An appreciation of surgical procedures also facilitates template designs that do not infringe on flap reflection and surgical instrumentation.

Because each specialist's perspective is somewhat limited to the scope of their particular training, having the restorative dentist tie all aspects of the treatment together maximizes the synergistic benefit of having input from various expertise (TABLE 1).

The Sequential Organization of Treatment

After completing the diagnostic evaluation, the information must be systematically organized in order to execute a successful treatment. Proper sequencing of adjunctive procedures such as orthodontic movement, hard and soft tissue augmentation procedures, and implant and abutment selection must all be addressed prior to implant placement. Coordination, sequencing, and timing of treatment may vary depending upon a number of factors. An understanding of how each of these factors influences the type of treatment recommended and sequence in which it is rendered will be discussed. The thought process involved in treatment planning the single-implant restoration is presented and a suggested sequence of treatment is proposed (TABLE 2).

Orthodontic Treatment Considerations

Once the decision to place an implant has been established and the surgical site evaluated for adequate spacing, the restorative dentist must choose whether or not orthodontic intervention is necessary.

As part of the preliminary treatment, lack of spacing, excess spacing, or unfavorable root angulation must be addressed. When too much space is available interproximally, one solution to correct the excess space is to overcontour the proximal surfaces of adjacent teeth. Although this option may be a valid option, it requires restorative treatment of the adjacent teeth and has the potential risk of developing poor emergence profiles. On the other hand, if a retained deciduous tooth is wider mesial-distally than the permanent tooth such as in primary molars, narrowing the interproximal tooth structure to the ideal permanent tooth size may be done prior to orthodontic consolidation of the excess space created.[2]

If the implant is to be placed in the esthetic zone, it may be better to conceal excessive space more distally. For example, if a space is too large to be closed orthodontically, the implant may be placed mesially in the ideal position, compromising the space distally in a less noticeable esthetic area.[3] Another useful indication for orthodontic treatment might be extrusion of an endodontically treated tooth with a hopeless periodontal prognosis.[4] This can favorably position the final position of the residual ridge crest more coronally by minimizing the extent of a vertical periodontal defect prior to extraction.

Another important consideration is adequate restorative interocclusal space. If the opposing tooth is supraerupted, compromises in the occlusal plane may result in unfavorable vectors of force due to excursive interferences, lack of interocclusal space for implant restorative components, and compromises in abutment height leading to lack of resistance and retention form in cemented restorations. Orthodontic intrusion of the opposing tooth may be an option if the tooth cannot be occlusally adjusted[5] (FIGURE 1).

Communication between the restorative dentist and the orthodontist should be very specific with regard to the desired tooth positions and angulations. In addition to study casts, a "work order" similar to those typically used for laboratory technicians, but outlining implant crown and implant fixture space requirements and very specific, precise measurements of desired tooth movement and direction may be utilized. Radiographs indicating desired root position may also be appropriate as part of this "work order" when root proximity and angulation impacts implant placement.

IDENTIFY THE ISSUES/ANALYZE AND ASSESS THE SITUATION:

EVALUATE IMPLANT POSITION:
- Angulation
- Spacing requirement
- Bodily position

HARD TISSUE ASSESSMENT:
- Bone width buccal-lingually
- Bone height on adjacent teeth
- Quality/density

SOFT TSSUE ASSESSMENT:
- Quality of tissue: biotype/amount of keratinization
- Adjacent gingival levels
- Papilla height

ADJACENT TEETH/OPPOSING OCCLUSION:
- Position/contours/contacts
- Angulation/root angulation
- Prognosis of adjacent teeth

IDENTIFY THE OVERALL GOALS:

SURGICAL	RESTORATIVE	ORTHODONTIC
Implant surface treatment	Abutment selection	Appropriate spacing
Implant design	Direct UCLA versus platform	Correction of adjacent teeth
Bone level versus tissue level	Prefabricated versus custom	Intrusion/extrusion
Tapered versus parallel	Material (zirconia, gold-coated, etc.)	
Internal versus external	Type of restoration	
Length, diameter	Cement versus screw	
Immediate versus delayed placement	Occlusal considerations	
Grafting/bone augmentation		
Immediate versus delayed provisionalization		

TABLE 2.

Orthodontic Treatment Sequencing

Depending upon a variety of factors, implant placement may be performed prior to, during, or following completion of orthodontic treatment.

Although rarely needed in the case of single-tooth implant restorations, implant placement prior to orthodontic treatment may be indicated in those situations where tooth movement may be facilitated by additional anchorage. Implants utilized for additional orthodontic anchorage may be of either a temporary type designed to be removed following completion of orthodontic treatment, or a definitive type to be utilized to support a final restoration. Planning for implants to be utilized to support final restorations presents a particular challenge as the implant position must be planned to accommodate the anticipated final restorative position of the teeth. A diagnostic cast, sectioned to allow a wax-up anticipating planned orthodontic tooth movement is made and duplicated. The ideal implant position is determined on this duplicate cast. Teeth that do not require orthodontic movement are utilized as reference points to transfer the proposed implant position back onto the preorthodontic cast for

FIGURE 1. A patient presented with a retained deciduous maxillary left canine and insufficient restorative space. In this case, orthodontic intrusion alone was not adequate esthetically. Although more difficult, the decision to minimally open the vertical dimension of occlusion by orthodontic extrusion of the adjacent posterior segments in conjunction with intrusion of the opposing mandibular canine was elected.

FIGURE 2. During the final stages of orthodontic treatment, the implant was placed immediately at the same surgical appointment the deciduous canine was extracted.

radiographic/surgical template fabrication. Appropriate radiographs are taken utilizing the template and the template is then utilized for implant placement prior to initiation of orthodontic treatment.

Commonly, implant placement is performed following completion of orthodontic treatment and stabilization of final tooth position. Although the outcome is more predictable, performing orthodontic then surgical procedures sequentially does add to the total treatment time. In addition, orthodontic retention is needed that does not interfere with implant surgical procedures to avoid relapse while waiting for osseointegration. An advantage of waiting until final orthodontic treatment is completed prior to dental implant placement is that the removed brackets and archwires will not interfere with implant placement.

If orthodontic treatment does not interfere with ideal implant placement and position, the two procedures may be performed concurrently. However, unless implant placement is needed in order to provide additional anchorage to facilitate orthodontic treatment, it is preferable to perform implant placement during the stabilization phase of orthodontic treatment, immediately following final tooth movement (**FIGURE 2**). Having an integrated implant fixture ready to restore at the completion of orthodontic treatment, immediately after bracket removal, reduces overall treatment time and may improve patient satisfaction.

Once orthodontic treatment is initiated, it is beneficial for the orthodontist to provide periodic diagnostic casts to the restorative dentist to monitor progress. This becomes particularly helpful to finesse the final tooth position as the patient nears the end of orthodontic treatment, ensuring a final result compatible with ideal implant position. Following completion of tooth movement, but prior to removal of brackets and archwires for stabilization, an impression is made in order to fabricate the surgical/radiographic template.

Coordination with the orthodontist is necessary to temporarily remove archwires and to deliver a temporary removable space maintainer, such as a vacuum-formed matrix to stabilize the arch just prior to implant surgery. Immediately following implant surgery, archwires may be replaced in lieu of the removable appliance while awaiting maturation of the implant-bone interface and stabilization of tooth position. In addition to enhancing patient comfort, this eliminates pressure over the surgical site by the removable appliance and obviates the necessity for multiple adjustments to accommodate for postoperative swelling. Reliance on patient compliance to wear a removable appliance is eliminated, reducing the possibility of orthodontic relapse following implant placement and prior to restoration.

In order to decrease the time, cost, and inconvenience of repeated removal and replacement of archwires for stage I and stage II implant surgeries, a one-stage implant surgical procedure may be considered when orthodontic treatment overlaps implant placement time. In addition, anticipating the clearance needed for surgical template seating, flap design, and surgical instrumentation when planning bracket placement and archwire design to facilitate implant placement may eliminate the need for repeated archwire removal and replacement altogether.

Whether implants are placed before, during, or at the end of orthodontic treatment, evaluation of diagnostic casts by the restorative dentist made prior to bracket removal will avoid the inconvenience and potential embarrassment of bracket replacement should further tooth movement be needed to optimize results.

Surgical Treatment

Prior to any treatment, the surgeon and restorative dentist must determine which implant system to place during the presurgical discussion. Implant configuration (tapered versus parallel) and implant connection (internal versus external) should be restoratively driven and decided prior to surgery. The approximate length and diameter can be determined by radiographic evaluation, however, the exact implant length and diameter are variable factors that are definitively made at the time of surgery.

Implant Selection Criteria

SURFACE TREATMENT

Deciding on an implant system based on surface technology is not as significant a factor today since all current major implant systems have shown integration with high levels of success.[6] Over the years, manufacturers have attempted to enhance their implant surfaces. From the tradition-

al machined, smooth surfaces, the newer roughened surfaces have consistently proven themselves to be superior in terms of quality of osseointegration as well as time of osseointegration.[6] These enhanced surfaces are more bio-reactive and thus may also lend themselves to earlier loading protocols than the original machined-surface implants.[7] Selecting a major manufacturer can be beneficial since it is more likely that a reputable business will still exist if, and when, components need replacement.

IMPLANT DESIGN

Most manufacturers now offer both a bone and tissue level implant. Because tissue level implants potentially run the risk of showing the metal collar through thin biotypes, there is a trend toward placing collarless bone level implants, which are advantageous in esthetic applications.

Another implant characteristic is the configuration of the body, which can either be tapered or parallel-sided. Due to the configuration of tapered implants, they can be used in sites with compromised bone width or in close proximity to adjacent roots. These implants are, however, more technique-sensitive because of the need to place them at the precisely drilled depth in order to engage all of the implant threads.[8] Parallel walled implants are less technique-sensitive and changes in vertical position or angulation can be made more easily. In extraction sites, parallel implants will engage the socket walls more effectively, providing added primary stability.[8]

With regard to the implant-abutment interface, the type of connection plays a significant role in stability of the abutment. Potential problems such as screw loosing and fracture are also influenced by this connection. In the past, screw loosening has been observed up to 40 percent in prospective studies with single molar implant restorations being the most common.[9,10] Because of this, implant manufactures have focused their marketing attention on connection design. Two such implant-abutment interface designs are the internal and external connections.

Furthermore, a taper on the internal aspect of the abutment connection provides a more intimate "slip joint" connection.[11] This Morse taper actively engages the internal walls of the implant creating a tight seal to prevent the ingress of bacteria as well as potential screw loosing.[12]

THE DIAMETER OF the selected implant should ideally correspond to the emergence profile of the tooth being restored.

The internal conical design has shown to increase the resistance to bending moments at the implant-abutment interface when compared to a standard external hexed butt joint. This was observed in the original ITI system (Institut Straumann AG) with an 8-degree conical interface as well as Astra's Conical Seal design (Astra Tech AB) which had an 11-degree taper.[13] Both tapered designs allowed forces to be absorbed by the implant-abutment connection and transferred to the implant-bone interface. Unlike the external connection where abutment screw and preload are the determining factors in stability of the connection, the internal tapered connection creates a frictional lock protecting the abutment from excursive lateral forces. With regard to stress concentrations at the implant-abutment connection, the internal connection is preferred over the external type for single-tooth restorations.[14]

In terms of anti-rotation, the presence of a hex on either the internal or external connections is ideal for single-tooth restorations.[15] Additionally, a larger and broader interproximal contact area of the final restoration may further assist in terms of its rotational resistance.

IMPLANT DIMENSION

Implant dimension is somewhat constrained by anatomic limitations. Ideally, an implant at least 10 mm long should be used since shorter implants have been shown to have a lower success rate.[16] Apart from a biomechanical advantage the implant diameter choice is esthetically more essential.[17] The diameter of the selected implant should ideally correspond to the emergence profile of the tooth being restored. A maxillary lateral incisor would require a regular or narrow platform while a molar tooth would benefit from a wide platform implant. This should be selected based on the width of the edentulous space and the desired emergence profile of the restoration. Wide diameter implants will have greater surface area and improve stress distribution to bone.[18] Usually, 5 mm diameter implants are indicated in molar areas, 4 mm in premolar and anterior regions, and narrow implants (3 mm to 3.5 mm) may be used in sites with limited space, such as maxillary lateral incisors and mandibular incisors.

IMMEDIATE IMPLANT PLACEMENT

The decision to place an implant immediately following a tooth extraction should be made on a case-by-case basis depending on whether or not the extraction site is free of acute infection and where the proper diameter implant will engage enough of the extraction site to achieve primary stability. With regard to survival rates, the short-

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term clinical outcomes have been comparable for both immediate and delayed implant placement.[19] However, the long-term success involving peri-implant health, bone loss and esthetic outcomes seem to be inconclusive from lack of data.[20] As such, immediate implant placement continues to be a somewhat controversial topic in implant dentistry. Proponents of immediate placement do however cite shorter treatment times and greater patient satisfaction as advantages compared to a delayed protocol.[21]

COORDINATION OF HARD AND SOFT TISSUE GRAFTING PROCEDURES

During the implant placement, grafting procedures may be indicated to increase bone volume and augment sites so that implant can be placed in the most favorable restorative position.[22] The decision to simultaneously place a graft and the implant depends on the extent of grafting required as well as the amount of primary stability of the implant.[23] The decision to graft should be made with the patient after thorough discussion of the risks and benefits of the proposed procedures. Detailed evaluations and hard tissue grafting options will be further discussed in the article on hard tissue considerations.

Once an adequate amount of bone is present to place the implant, the quantity of bone must be assessed for soft tissue support. Since soft tissue architecture is dictated by the underlining hard tissue anatomy, the need for adjunctive hard tissue grafting procedures may be indicated for apparent soft tissue deficiencies.

If soft tissue grafting is required, the decision needs to be made as to the timing of the grafting. It may be performed at the time of implant placement or at second stage. One advantage to delaying soft tissue grafting procedures until second stage is to allow time for osseointegration to occur and any bone grafting procedures to properly remodel. Once the hard tissue contours are stable, the need for soft tissue augmentation can be achieved more predictably. At the time of implant placement, the surgeon should make an index to register the position of the implant once it is placed and before proceeding with primary closure of the tissues. The restorative dentist/lab can then fabricate a custom healing abutment or a provisional restoration that can now be used at the second-stage surgery and grafting procedure. The graft is allowed to heal and mature against a more anatomically shaped emergence profile, instead of a standard healing abutment.

IMMEDIATE IMPLANT placement continues to be a somewhat controversial topic in implant dentistry.

IMMEDIATE IMPLANT PROVISIONALIZATION

From the patient's perspective, immediate placement of a provisional restoration at the time of implant placement offers a number of distinct advantages. It provides for an immediate provisional restoration that portends the final fixed restoration and eliminates the potential negatives of wearing a removable prosthesis. From a surgical/restorative perspective, an advantage of the immediate provisional restoration is that by mimicking the contours of the proposed restoration, it acts as a soft tissue scaffold, its emergence profile helping to maintain or recreate ideal soft tissue architecture.[24] Factors determining whether it is advisable to immediately provisionalize an implant at the time of placement include the degree of primary implant stability and the ability to minimize loading. It is critical that patients are advised to eat a soft diet and to avoid directly functioning on the provisional restoration during the healing period.

However, simply informing the patient to avoid biting on the implant can be unpredictable. Occlusal forces must be controlled, in order for the restorative dentist to place a provisional the same visit that the implant is placed. Although lateral forces on anterior teeth can be more significant, overall occlusal loads are less compared to posterior teeth therefore favoring immediate provisionalization in the anterior region. To prevent detrimental forces during the early stages of osseointegration, the provisional restoration is adjusted so no centric or eccentric occlusal contacts exist. In addition, contacts on adjacent teeth can favorably protect the implant from excursive interferences. It may also be wise to have a back-up removable provisional prosthesis such as an Essex stent in case primary stability of the implant cannot be achieved at the time of surgery and the implant provisional cannot be delivered.

Restorative Treatment Considerations

During the initial phase of the restorative treatment, the provisional implant restoration is evaluated for esthetics and function. Adjacent contours of hard and soft tissue are allowed to stabilize prior to fabrication of the definitive restoration. This can be particularly critical in the esthetic zone. Once the provisional implant restoration has had sufficient time to mimic the shape and esthetics of the final restoration, an impression can be made to aid the laboratory technician. This is one of the most predicable ways to facilitate transition into the final restoration.

Abutment Selection

The restorative dentist must be aware of the various prosthetics components that are available for the different systems that the surgeon may be utilizing. The implant system used should be dictated by the restoring dentist as there may be subtle differences between the systems that may be beneficial to the particular case.

For example, one design philosophy incorporates the use of an abutment that is slightly narrower than the implant platform such that the abutment-implant interface occurs medially to the implant axial surface. Frequently referred to as "platform switching" (3i), "conical seal" (ASTRA) or "platform shifting" (Nobel Biocare), this concept supposedly keeps the bacterial inflammatory response found at the abutment-implant junction or micro-gap, away from the bone interface. One study has shown maintenance of crestal bone at its initial position instead of remodeling to the first or second thread.[25] Application of this concept may be more critical in areas exhibiting thin interproximal bone adjacent to the implant site. If the restorative dentist wishes to prescribe to this philosophy, the decision should be communicated with the surgeon to ensure the correct choice of implant system.

With the growing number of implant manufactures and restorative material, the abutment choices may seem vast and confusing. There are standard prefabricated abutments or custom abutments, both of which may have a straight or angled profile.

In the single-tooth implant, direct UCLA "cast-to" abutments can be less complex than multiunit standard abutments by simplifying the number of components. If an implant is placed restoratively in the ideal position, the access channel should exit through the occlusal portion of posterior teeth and the cingulum or incisal edge of anterior teeth.

When angulation issues are a concern, prefabricated angled and preparable abutments will provide a limited degree of correction. "Cast-to" UCLA-type abutments can have greater flexibility in angulation adjustment through the use of a custom abutment. However, the additional coping will be an added cost to the lab fee. This should be a main concern for the restoring dentist since poor angulation issues in implant placement can restoratively be a financial burden.

Also gaining popularity, are the CAD-CAM custom abutments meant for cement-retained restoration. Made from titanium or zirconia, they are milled from blocks, after scanning and designing it on a computer system. Abutment material is a function of both esthetics and strength. For its superior esthetic qualities, the use of zirconia has increased in popularity. However, in the anterior region of esthetically demanding patients, thin periodontal biotype and limited occlusal forces, zirconia abutments are a favorable choice, as they are nonmetallic in color, and do not produce a grayish appearance through the tissues. In the posterior regions, conventional gold nitride-coated titanium or high noble cast abutment can provide adequate strength with sufficient esthetics.

WHEN DESIGNING THE occlusion of the restoration, it is important to analyze the existing occlusion and guidance pattern prior to restorative treatment.

Type of Restoration

Originally, implant restorations were all screw-retained. Screw-retained restorations are easily retrievable if adjustments or repairs are needed. Restorations that came loose could be re-torqued as well. The cement-retained restoration was originally designed to mimic conventional crown and bridge procedures simplifying treatment for the restorative dentist. Cemented restorations are more ideal in controlling occlusal contacts and situations where esthetics may be compromised with the use of a screw access channel. With cement-retained restorations, occlusal forces can be directed more vertically down the long access of the crown rather than axially around the screw access. Even in cement-retained restorations, there is an abutment screw in the system that has an equal chance of coming loose as the one holding the screw-retained restoration. Whether a cement-retained, or screw-retained restoration is utilized, the abutment screw should be tightened utilizing a torque driver to deliver the torque specified by the manufacturer. The introduction of the torque driver has allowed quantitative consistency in tightening of screw joints in addition to increasing contact forces between implant and abutment components.[26]

However, with better internal connection implants and the more predictably reduced incidence of screw loosening, the cement-retained restorations have gained more popularity amongst practitioners. When encountering a patient with a known parafuntional habit and the dentist anticipates a potential problem with a higher anticipated load and porcelain fracture, a screw-retained restoration would be favored. This will allow for a predictable removal of the restoration for repair.

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Occlusal Considerations

When designing the occlusion of the restoration, it is important to analyze the existing occlusion and guidance pattern prior to restorative treatment. Guidance in excursive movements should preferably be on natural teeth due to their added mechanoreceptive feedback. If a canine tooth is being replaced by an implant and canine guidance is desired, the excursive contacts should be distributed on adjacent teeth such as the first premolar or lateral incisor during lateral movement. This concept of group function will allow a more favorable allocation of forces over the implant. In a case where the length of a restoration will fulfill the esthetic requirements but unfavorably load the implant, the authors suggest that a concept observed in natural dentition may be utilized and guidance should be adjusted so that only the critical last 1 mm of closure is contacting in excursive movements.[27]

Implants tend to accommodate axial loads better than non-axial loads.[28] Unlike natural teeth, implants are ankylosed to bone and do not display the level of resiliency imparted by the periodontal ligament. Thus the occlusion of the restoration must to be carefully adjusted to compensate for the forces being absorbed by the visco-elastic properties of the surrounding bone. If the occlusion is not adjusted correctly, there is a risk of overloading the implant, which may lead to crestal bone loss and potential implant failure.[29]

One potential method of dealing with the difference in visco-elasticity between dentition and implants is to develop light centric contact in maximum intercuspal position and no eccentric contacts on lateral movements. When the patient occludes lightly, the occlusion is adjusted so that a 12 microns shim stock is able to just pass over the implant restoration without tearing while being held firmly by the adjacent teeth. Upon forceful closure, this allows improved tactile mechanoreception on the natural teeth. According to the literature, there is currently no evidence-based research to support a specific concept of implant occlusion. However, based on clinical experience and existing literature, guidelines may be recommended for optimal implant occlusion and management of complications related to implant occlusion.

The occlusal table of the restoration should be kept as minimum as possible.[30] Since the mesial-distal width cannot be changed much, as the restoration needs to achieve a contact area, the buccal-lingual dimensions may be narrowed slightly. This allows for a smaller occlusal table and minimizes the risk of developing an interference and implant overload.[30]

UNLIKE NATURAL TEETH, implants are ankylosed to bone and do not display the level of resiliency imparted by the periodontal ligament.

Communication Is Key

Good communication between all specialists involved including the patient is essential for a successful treatment. Communication will facilitate the management of cases and reduce the risk of complications. The restorative dentist should be the primary individual sharing information between specialties and conveying their objectives and requirements to one another. This section provides the practitioner with suggestions as to how to best communicate pertinent information to each implant team member (**TABLE 3**).

Facilitating Communications With the Implant Surgeon

Communication with the implant surgeon is probably the most crucial step in implant planning. Once the implant is placed, its position cannot be altered or removed without causing further complications. The restoring dentist and implant surgeon must decide on the ideal angulation and bodily position before requesting a radiographic scan. The scan should be as recent as possible to currently reflect the anatomical boundaries.

Restoratively speaking, the two crucial constraints that need to be conveyed to the surgeon in the surgical guide are the proposed CEJ level which dictates implant depth 2-3 mm apical and the restoration contours that determine angulation such that the restoration will be loaded down the long axis, and the access will allow for a favorable exit if screw retention is desired. In addition, the surgeon should recommend any guide modifications that will facilitate easier surgical access. For example, since the implant's restorative occlusal anatomy on the surgical guide provides little clinical value, the occlusal cusps can be reduced to facilitate easier surgical access.

However, this should be done carefully as to not adversely misinform the surgeon of the restorative contours. If during the surgical procedure a soft tissue flap is reflected, it must not interfere with the seating of the guide. Lastly, where the surgical guide rests on adjacent teeth, an occlusal notch can be made to conveniently verify complete seating on the teeth.

During implant placement, the fewer adjustments needed to accommodate the surgery, the more smoothly the treatment will proceed. A prearranged agreement between the surgeon, restorative dentist, and patient may be made to avoid indecision when changes in planned implant po-

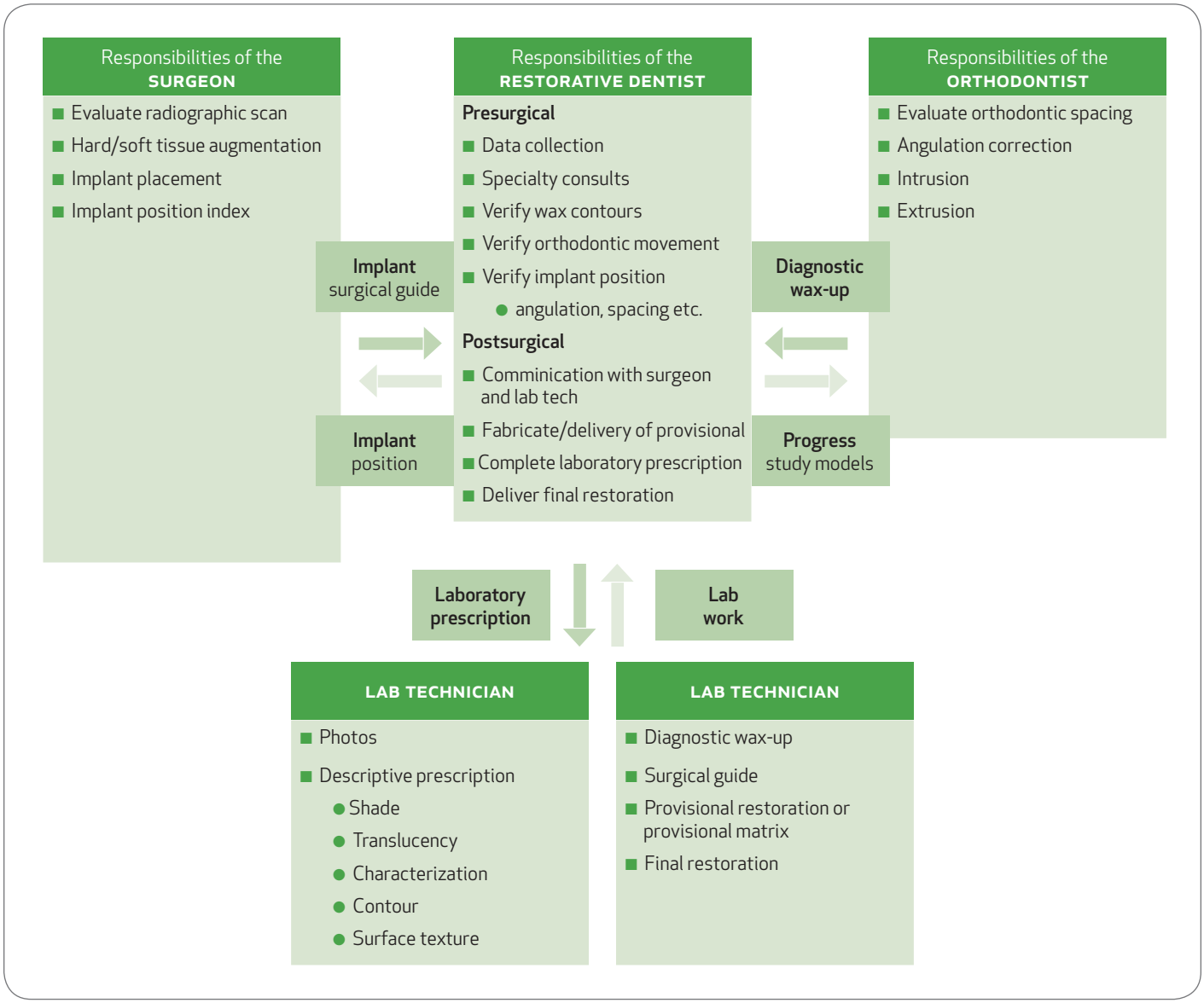

TABLE 3.

sition or angulation must be made to accommodate conditions found at surgery. Protocols for deciding whether implant angulation should be changed and to what extent, or ideal position maintained with simultaneous grafting procedures should be worked out prior to surgery.

Appropriate timing of provisional restoration delivery should be coordinated between the surgeon and restorative dentist. Due to the uncertainty of immediate provisionalization until the time of implant placement, the restorative dentist should be ready to deliver an alternative provisional restoration. If initial stability is established, a provisional can be delivered facilitating soft tissue adaptation and the patient's esthetic satisfaction. However, if poor initial stability is present, delivery of a custom healing abutment can be an alternative method of achieving soft tissue adaptation without risk of occlusal loading (**FIGURE 3**).

Soft tissue augmentations, such as keratinized free gingival grafts, should be accomplished during the second stage when the implant is uncovered and provisional delivered. This approach allows the provisional restoration to mold soft tissue contours appropriately. The need for hard tissue augmentation should be decided upon by the surgeon at time of implant placement or decided at the treatment planning stage.

Although not always possible, if the implant shows adequate stability, a

FIGURE 3. A custom healing abutment following the contours of the extracted canine was fabricated to maintain the scalloped architecture. The height of the abutment was just above the tissue level away from any occlusal contacts. A provisional denture tooth was then bonded to the archwire.

FIGURE 4. After orthodontic treatment was completed on the upper arch and the implant allowed to fully osseointegrate, veneers were prepared on Nos. 6-10 and provisionalized with a splinted restoration to stabilize the arch. At this time, the implant was also loaded with a provisional restoration.

surgical index may be taken at the time of surgery to fabricate a provisional. Whether the implant is stable will dictate whether the provisional is delivered. If initial stability cannot be achieved at the time of implant placement, a surgical index will at least permit delivery of a provisional restoration at a later date.

Facilitating Communications With the Orthodontist

When orthodontic treatment is required, it helps to show the orthodontist proposed teeth positions through a diagnostic wax-up. Providing exact spacing requirements minimizes confusion and error. If spacing is an issue, the dentist should specify where to ideally position the teeth prior to implants. In addition to the desired crown position, correction of adjacent root angulation needs to be addressed if they interfere with the proposed implant site.

Minimum space requirements for implant placement must be specific to avoid confusion. For example, requirements for root spacing must be measured at the crestal bone level, root surface-to-root surface, and not at the level of the crown's interproximal contacts. The fixture form will determine necessary inter-root space requirements at the apical root level.

Depending on the implant system, the orthodontist should be informed of the necessary interocclusal space in determining whether orthodontic intrusion extrusion or occlusal adjustment is necessary for the opposing tooth. If extrusion is decided upon to orthodontically augment the ridge, occlusal adjustments must be coordinated with the restorative dentist during concurrent extrusive movement.

The method of provisionalization must be decided by the restorative dentist after implant placement. If orthodontic treatment is still in progress, a denture tooth can be bonded to the archwire. Alternatively, a removable interim prosthesis can be worn. If the adjacent teeth require restorative treatment, splinted provisional restorations can also be used to maintain spaces. (**FIGURE 4**).

In order to facilitate anticipated surgical implant procedures, the orthodontic brackets and archwires should be designed and placed in such a manner as to not impede these surgical procedures. This negates the necessity to remove brackets and archwires to accommodate implant surgical procedures. This also somewhat decreases the logistical burden of coordinating visits between the restorative dentist, orthodontist, and implant surgeon every time the surgeon or restorative dentist needs to get access to the implant site.

In addition to accommodating implant surgical procedures, it is often beneficial if the archwires can be placed in such a manner as to facilitate any needed radiographic surveys such as a CT scan along with the concomitant radiographic/surgical template. Although conventional dental periapical radiographs should be taken to assess root angulation and proximity prior to bracket removal, if the CT scan can be taken with the brackets and radiographic template in place, should a problem with root angulation become apparent in the CT scan, further orthodontic corrections can be made without the inconvenience of having to replace prematurely removed brackets.

As such, it is critical that the progress of orthodontic treatment is carefully monitored by the restorative dentist with adequate opportunities to check on osseous and soft tissue contours and adjacent crown and root positions relative to the proposed implant site prior to bracket removal. Although archwire removal can sometimes facilitate some implant surgical procedures, bracket removal should not be done by the orthodontist until it is certain that orthodontic treatment has met all the goals of treatment and is complete, and with the specific approval of the restorative dentist. Needless to say, this avoids some potentially serious patient management complications should further orthodontic treatment is deemed necessary to optimize treatment results.

Facilitating Communications With the Laboratory Technician

Good communication with the lab technician is just as important as with the other specialists involved. This entails a thorough laboratory prescription with all the necessary information to assist the technician without having them rely on their own judgment. A successful treatment always begins with a diagnostic wax-up. Although provided by the lab technician, the restoring dentist should be able to evaluate, critique, and relay import information from this diagnostic tool and radiographs to the surgeon and orthodontist. The wax-up will help the restoring dentist decide if orthodontic movements are necessary and later duplicated for fab-

rication of the surgical guide. That is why it is essential to communicate the exact position of the proposed CEJ and restoration contours in the diagnostic wax-up.

In the anterior esthetic region, capturing tissue architecture is critical in achieving a predictable outcome. Minimizing the amount of soft tissue changes while transitioning from provisional to definitive restoration will result in a more predictable treatment. Therefore, it is best to provide the technician with an impression of the soft tissue in its most stable state. This can be achieved through the use of either custom-made impression copings that mimic the exact subgingival emergence profile of the provisional restoration or using the actual provisional if time allows.

When requesting the impression to be poured, a type IV low expansion die stone should be specified. In addition, the use of a silicone soft tissue cast around the implant analogs can be useful in fabricating slightly overcontoured restorations to carefully manipulate the gingiva and can easily be removed to verify the seating of the restoration on the master cast (**FIGURE 5**).

If the lab is to fabricate a provisional, information regarding contours to shape the soft tissue is necessary. If attempting to guide papilla regeneration, specify the addition of material to be displaced mesial-distally. Or if the facial tissue is thin, it is recommended that facial contours be slightly flatter than the adjacent natural tooth contours in order to minimize apical displacement of the free gingival margin.[31]

Communicating proper esthetics is even more crucial when working in the anterior region. The more information one can provide the technician, the better the outcome. In addition to taking a shade, information regarding translucency, specific characterizations, contours, and surface texture should also be conveyed. Multiple photos with at least two shade tabs next to adjacent teeth should be included. Diagrams with shade mapping can ensure an accurate description is provided for the technician. Other useful technique include printing out intraoral photos and drawing out the actual changes that need to be made directly on the paper or the addition of a different colored wax added to the porcelain showing exact contour modifications.

WITH REGARD TO THE single-tooth implant restoration, perhaps the most critical aspect of communication with the patient is predicting the expected esthetic result.

Facilitating Communications With the Patient

Avoiding misunderstandings with patients regarding the timing, sequencing, cost, and expected treatment outcomes is a critical aspect in the success of any patient treatment.[32] Advances in implant dentistry techniques have lead to increased predictability, enhanced functional and esthetic results. Understanding patient expectations is crucial to determining the most appropriate treatment.

Advertisements that tend to minimize the complexity of the multitude of factors that need to be taken into consideration in order to obtain optimal, long-lasting esthetic results may sometimes mislead patients as to what is actually involved in replacing the single missing tooth with a dental implant restoration. This may be true regarding not only the time needed for treatment, the cost of treatment, but also for the necessary prerestorative steps needed to prepare the site for optimum esthetic and functional results.

For this reason, it is critical that an initial plan, outlining all anticipated procedures along with sequencing of those procedures, is presented to, thoroughly discussed with, and understood by the patient prior to the initiation of treatment. As previously stated, as implant placement is restoratively driven, it is usually the restorative dentist who becomes the central figure in coordinating the various aspects of dental implant treatment. It is also the restorative dentist who becomes the primary resource for answers to the patient's questions regarding their treatment, and the individual who the patient looks to for guidance and support throughout these procedures.

With regard to the single-tooth implant restoration, perhaps the most critical aspect of communication with the patient is predicting the expected esthetic result, particularly with regard to issues regarding gingival balance, apparent gingival root prominence, and papilla contour. Based upon the understanding of the biologic parameters that determine sustainable gingival contours (interproximal bone height, distance to the interproximal contact, and the implant/tooth interproximal bone width), one should be able to give the patient a realistic expectation prior to initialing treatment of what the final gingival contours should be.

Based on the particular parameters the patient presents with, a diagram or photograph illustrating the expected result should be shared and discussed with the patient. Particularly in the esthetic zone, failure to meet patient expectations can lead to "failure" of treatment and patient dissatisfaction, even in light of generally favorable results.

FIGURE 5. An impression was made with a soft tissue cast to allow for minimal overcontouring of the restoration if the tissue architecture needed modification.

FIGURE 6A. Delivery of the definitive veneers Nos. 6-10 and provisional implant restoration on No. 11. Patient was satisfied with the esthetic results and maintenance of the soft tissue architecture.

FIGURE 6B. Given the outcome of having the screw access through the incisal edge, either a prefabricated angled abutment or custom abutment with a cement-retained restoration is indicated. An anterior group function occlusal scheme was designed to control the guidance in excursive movements.

Conclusion

If the dentist can reliably anticipate the outcome of treatment, patients will be more likely to accept care. In order to have predictable results, long-term objective goals must be envisioned prior to the start of treatment. In relation to the single-tooth implant restoration, these objectives can be broken down into surgical, orthodontic, and restorative requirements. Understanding the sequential thought process and addressing the pertinent issues are only part of the treatment. Good communication with all specialties including the patient will ensure greater confidence and a more successful treatment (**FIGURES 6A–B**). ■■■■

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The Single-tooth Dental Implant: Practical Guidelines for Hard Tissue Augmentation

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ABSTRACT With the increased popularity of implants and focus on esthetics, there is great emphasis on idealized bone foundation and soft tissue contours. The goal of reconstructive procedures is to provide peri-implant bone that support and maintain gingival contours. This article reviews ridge deficiency diagnosis and predicts the need for bone augmentation before tooth extraction. It also presents early intervention to minimize bone loss, various bone reconstruction techniques, and suggests predictable methods for different clinical scenarios.

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Clinical management of single missing teeth with dental implants has become common and well accepted. With current techniques and protocols, success of dental implants is more than 90 percent in both the maxilla and mandible, with even higher success in the anterior regions.[1-2] To date, outcome measures generally focus on implant survival, requirements being the implant is present and functioning. Even when more stringent criteria is utilized including radiographic bone loss, implant hygiene, plaque and bleeding index, as well as resonance frequency measurements of stability, esthetics is rarely evaluated in reports of implant success.[3-5]

With the increased popularity of dental implants and a paradigm shift from restoring function to restoring form and function, there has been a greater emphasis on establishing idealized bone foundation and soft tissue contours for optimal esthetic results. Specifically for dental implants in the esthetic zone, intact papillae with ideal facial gingival contours that are indistinguishable from adjacent natural teeth are the goals of therapy and demands of patients. Although this seems to be more critical in patients with high smile or lip lines, an ideal esthetic result is a common expectation for all implant patients. To this end, it has been suggested that maintenance or re-establishment of esthetic scalloped soft tissue lines

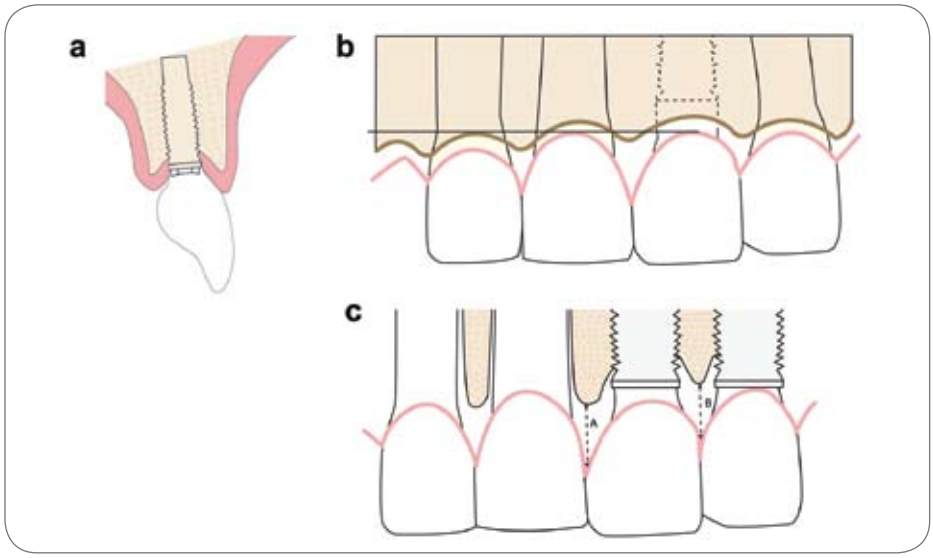

FIGURE 1. Peri-implant papilla and marginal gingiva depend on two supporting bone structures (a-b). The height and thickness of labial bone wall on the facial surface of the implant. This bone is responsible for supporting the marginal gingiva and provides soft tissue framing for a harmonious even gingival margin[5,14,15] and (c) the height of the interproximal crest of bone at adjacent teeth in single-tooth gaps and the height of the interproximal crest of bone in between implants in multiple teeth gaps. This bone is responsible for supporting the interdental papilla. The presence or absence of the peri-implant papillae depends on distances A and B between the alveolar crest and contact points. To maintain papillae, a distance of < 5 mm is required at A and a distance of < 3 mm is required at B.[7-10]

FIGURE 2. (A) The distance between the crest of bone and contact point can be assessed before extraction, and the probability of papilla preservation determined, and (b) periapical radiograph with surgical guide showing proposed future contact points and relationship to the alveolar crest.

FIGURE 3. Example of a thin gingival biotype.

FIGURE 4. Example of a thick gingival biotype.

and natural contours should be included when determining implant success.[6] To evaluate these post-treatment variables, meticulous and thorough assessment of hard and soft tissue parameters before implant placement should be included in the preimplant treatment planning phase.

The goal of hard tissue augmentation is to provide a foundation for ideal implant placement that not only allows for biomechanically sound implant positioning, but also supports soft tissue for optimal esthetics (**FIGURES 1A-C**).

In an assessment of hard and soft tissue contours in the esthetic zone, it is not uncommon for patients to have bony defects from periodontal disease, alveolar trauma, traumatic extractions, periapical infection, or lengthy period of edentulism. In these cases, clinicians must deal with either augmenting or camouflaging hard tissue deficiencies. Through the years, multiple procedures and augmentation materials have emerged to augment deficient bony ridges, which have created significant confusion in implant therapy.

This article presents practical guidelines for hard tissue augmentation. It is intended to help practitioners in decision making when facing various clinical situations. The guidelines are based on the authors' clinical experience and are not intended to represent an only one-way approach to the presented scenarios. Though this article only covers hard tissue augmentation techniques, the authors want to stress the importance of diagnosing and treating soft tissue deficiencies prior to, at the time of, and after implant placement. The topic of soft tissue regeneration will be covered subsequently in this issue.

Hard Tissue Assessment Prior to and at the Time of Tooth Extraction

At the initial treatment planning phase, patients should be informed if hard tissue augmentation will be or may be necessary. Here, it is important to highlight the current status of the patient's dentition and any bony deficiencies that are identified. The correct diagnosis at this time can assist in assessing hard and soft tissue quality and quantity. For example, if the tooth to be extracted is missing buccal bone due to previous periapical infection or if horizontal bone loss is present due to periodontal disease, the patient should be informed that this would have an impact on the position of the implant and esthetic outcome unless corrective measures are undertaken. This section will discuss alveolar ridge evaluation prior to and at the time of tooth extraction.

Crestal Bone Level Adjacent to Neighboring Teeth

The bone height of the interproximal crest of the adjacent teeth plays a role in the presence or absence of the peri-

implant papillae.[7-10] Even if techniques are utilized to prevent bone loss after extraction, the final result can only be as good as the interproximal crestal bone levels of the adjacent teeth. Therefore, diagnosis of deficiencies and prognosis of adjacent teeth, including both functional and esthetic demands of the patient, should be considered when treatment planning for an implant in the esthetic zone. Clinical studies have provided important measurements to determine predictability of papilla preservation and/or formation between an implant and adjacent natural tooth.[7-10] These studies have shown that a distance greater than 5 mm from the interproximal alveolar crest to the contact point reduces the probability of intact papillae (**FIGURE 1C**). To detect patients at risk for short peri-implant papillae, a detailed preoperative analysis of crest height of the adjacent teeth is necessary. A periapical radiograph obtained with a long cone parallel technique can give an accurate assessment of the crest of bone height for these measurements, which can be performed before the tooth is extracted (**FIGURE 2A**).

Height and Thickness of the Labial Plate of Bone

When gingival recession is not present clinically, the labial plate integrity and thickness can be assessed indirectly when the teeth are present by categorizing the gingival biotype.[11-12] It has been reported that hard tissue thickness can be relatively assessed by determining the gingival biotype.[13] A thin gingival biotype, with a highly scalloped gingival architecture, is often associated with thin labial bone plate (**FIGURE 3**). In contrast, a thick gingival biotype, featuring blunted contours of the papillae, is often associated with a thick labial plate of bone (**FIGURE 4**). In addition, thin gingival biotype is less likely to provide soft tissue stability after a surgical procedure than thick gingival biotype.[13] However, when clinical gingival recession is evident, there is an obvious loss of labial plate support. The height of the labial plate of bone (**FIGURES 5A-C**) will determine if a vertical augmentation procedure is needed to allow for a more coronal implant position, to create a more harmonious gingival margin. The labial gingiva soft tissue profile depends on the buccal bone thickness and height.[14-16] The overlying soft tissue cannot be regenerated without adequate labial plate thickness and height.[14-16] At the time of extraction, labial plate thickness (**FIGURES 6A-C**) will determine if resorption is likely to happen during extraction socket healing. The height of the labial plate can be assessed immediately after extraction by using a periodontal probe to measure the distance from the gingival margin to the labial crest of bone (**FIGURE 7**). With the periodontal probe, areas of fenestration and thin labial plate can be determined.

It is important to classify the socket at the time of extraction (**FIGURES 8A-D**). Elian in 2007 proposed a classification of extraction sockets, which has been modified here.[8] Class I sockets (thick labial bone plate) (**FIGURE 8A**) have labial bone that is not compromised in height or thickness, with no soft tissue recession. Due to the labial plate thickness, the blood supply is likely to be maintained. Class I sockets (thin labial bone plate) (**FIGURE 8B**) have labial bone that is not compromised in height but is compromised in thickness. Again, no soft tissue recession is present. Here, blood supply to the thin bone may not be adequate and there is

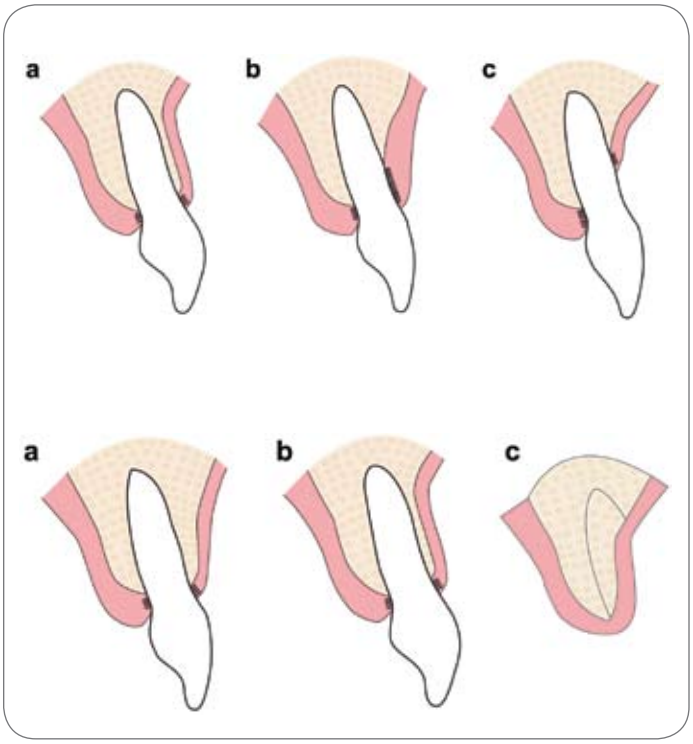

FIGURE 5. The height of the labial plate of bone will determine if a vertical augmentation procedure is needed to allow for a more coronal implant position: (a) adequate labial bone height; (b-c) deficient labial bone height with and without soft tissue recession. Extraction socket augmentation in (b) and orthodontic extrusion in (c) can bring the labial plate to a more coronal position.

FIGURE 6. Labial plate thickness and extraction socket healing: (a) labial plate is usually maintained in sites with thick plate; (b) labial plate resorption in sites with thin plate; and (c) labial plate resorption can lead to soft tissue collapse and a knife-edge ridge.

FIGURE 7. A periodontal probe can measure alveolar crest to gingival margin distance.

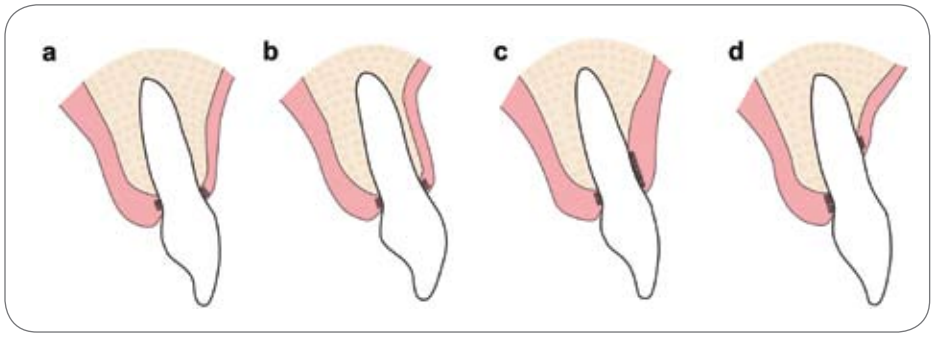

FIGURE 8. Extraction socket classification: (a) class I, thick labial plate; (b) class I, thin labial plate; (c) class II; and (d) class III. (Modified from Elian.[8])

FIGURE 9. Orthodontic extrusion. (A) anterior teeth to be extruded with gingival recession and long clinical crowns; (b) tooth roots reduced after orthodontic extrusion; (c) temporary prosthesis in place showing short crowns due to significant orthodontic extrusion.

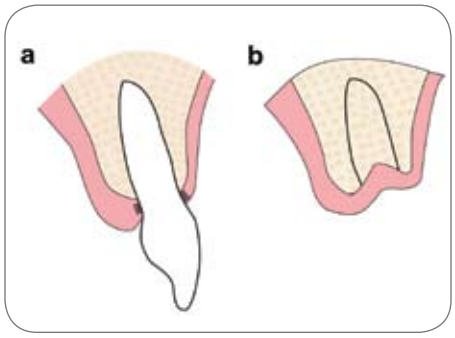

FIGURE 10. Soft tissue will compete for the space and result in a bone fill below the level of the alveolar crest. (A) Tooth before extraction and (b) resultant collapse of soft tissue into extraction site.

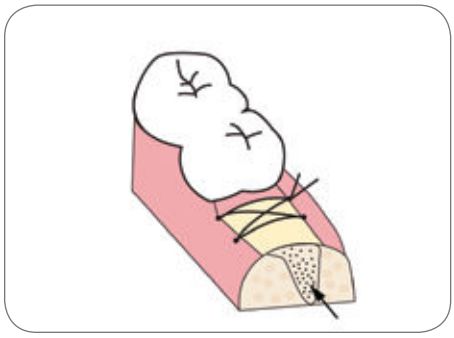

FIGURE 11. Extraction socket augmentation utilizing the use of osteoconductive space maintaining graft (arrow) and hemostatic dressing or barrier membrane.

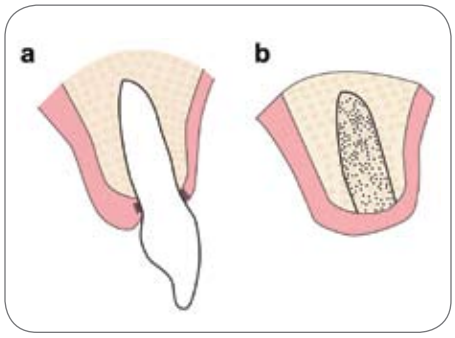

FIGURE 12. Extraction socket augmentation will result in optimal bone fill and a better alveolar ridge form and contour. (A) Tooth before extraction and (b) resultant maintenance of alveolar ridge contours.

a high probability of labial plate resorption. Class II sockets (**FIGURE 8C**) have a labial plate that is compromised in height and thickness (i.e., loss of labial plate) but soft tissue contours are maintained. Class III sockets (**FIGURE 8D**) have a labial plate that is compromised in both height and thickness (i.e., loss of labial plate), with resultant soft tissue recession.

Hard Tissue Augmentation Prior to and at the Time of Tooth Extraction

Orthodontic Tooth Extrusion

Clinical situations with reduced vertical bone on teeth adjacent to planned implant sites are challenging. Currently, there are no surgical techniques available to predictably regain lost interproximal crest of bone height on the adjacent teeth. In an attempt to regain this lost tissue, orthodontic tooth extrusion techniques before tooth extraction have been proposed[17-19] (**FIGURES 9A-C**). During the forced eruption, bone and gingiva surrounding the extruded tooth migrate coronally. Such vertical augmentation, especially for the labial bone plate and interproximal crest around the extruded tooth, can allow for a more coronal implant position. However, no clinical studies with long-term results have been presented to date.

Extraction Socket Augmentation

Rationale For Socket Augmentation

Bone formation in extraction sites proceeds slowly in an apical to coronal direction and from the outside to the center of the socket, along a dense network of collagen fibers.[20] In normal, nonaugmented situations, soft tissue proliferation and invagination occur and result in a concave bony defect with the bone fill below the level of the alveolar crest (**FIGURES 10A-B**). The principles of guided bone regeneration appear to be applicable to extraction socket healing.[21]

Wound isolation by utilizing an occlusive membrane or by placing an osteoconductive space-maintaining graft material in the socket will prevent the invagination of the fast growing oral epithelium into the healing socket (**FIGURE 11**). Since osteoblastic cell proliferation and trabecular bone formation occur four and eight weeks after extraction, maintaining that space until bone regeneration can occur is recommended.[22] Augmentation provides a better alveolar ridge form and contour allowing for more optimal future dental implant placement (**FIGURES 12A-B; FIGURES 13A-H**). Class I (thick labial

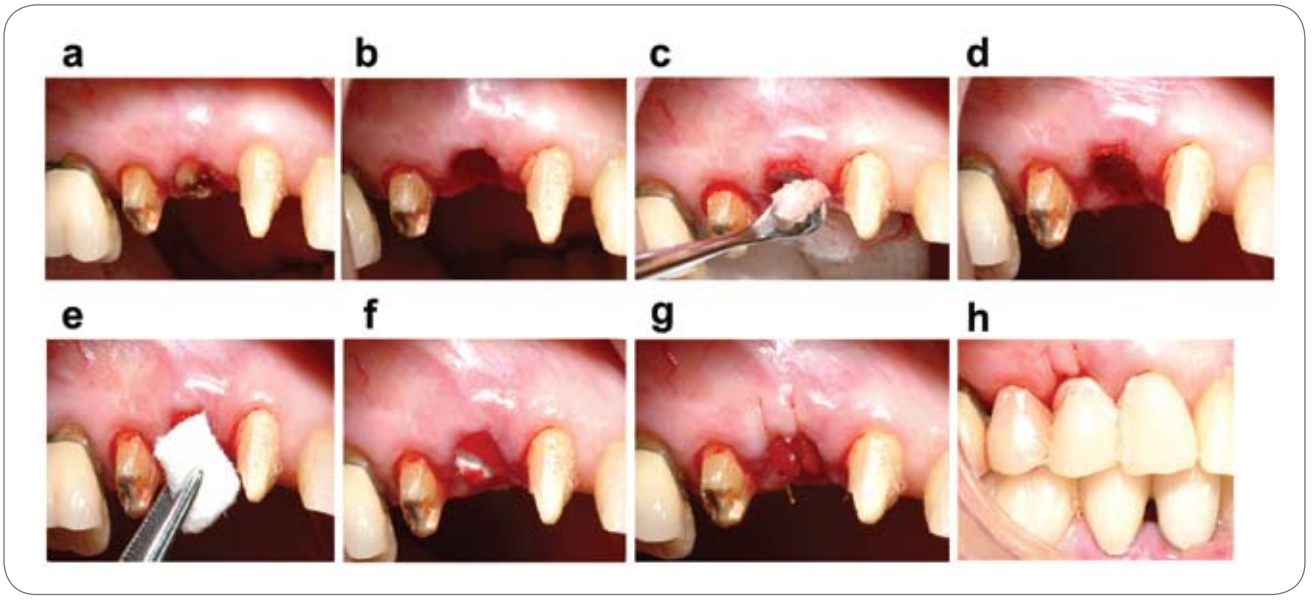

FIGURE 13. Site to be augmented (a) before and (b) after atraumatic extraction; (c-d) augmentation material is used to graft the socket; (e-g) a hemostatic dressing is placed and secured with sutures; and (h) provisional restoration is in place.

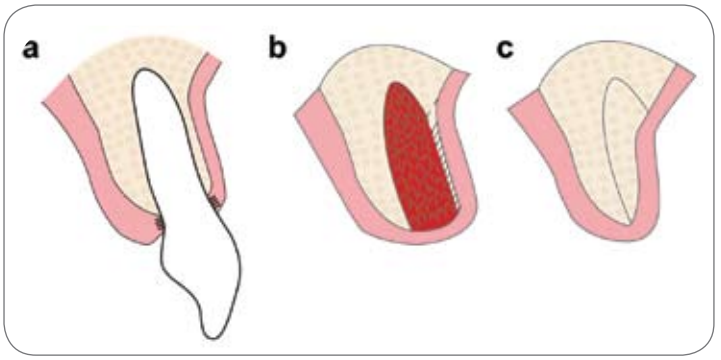

FIGURE 14. Class I (thin labial bone plate). (A) Tooth before extraction; (b) initial healing stage with blood clot; and (c) knife edge ridge.

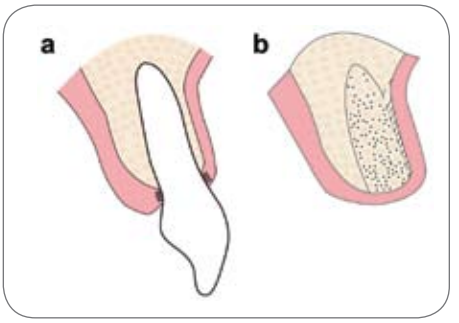

FIGURE 15. Class I (thin labial bone plate). Extraction socket augmentation prevents soft tissue collapse. (A) Tooth before extraction and (b) ideal ridge form and contour.

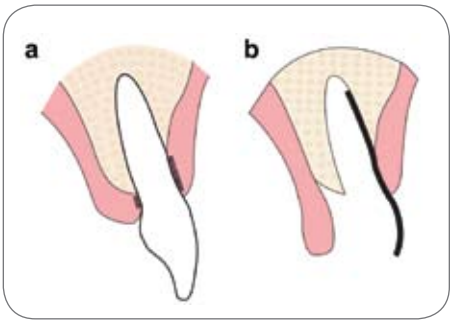

FIGURE 16. Class II extraction socket. (A) Tooth before extraction and (b) guided bone regeneration with barrier membrane.

bone plate) extraction sockets that are not augmented at the time of tooth extraction may result in a residual ridge with a concave bone defect at the crest of the ridge (**FIGURE 10B**), whereas class I (thin labial bone plate) usually ends up as a knife-edge ridge with horizontal deficiency secondary to labial plate resorption and soft tissue collapse (**FIGURES 14A-C**).

To support extraction socket healing in the case of a thin labial bone plate, the graft material must have a space-maintaining capability to withstand soft tissue collapse in the event of further labial plate resorption (**FIGURES 15A-B**). The use of demineralized freeze-dried bone allograft, DFDBA, in these extraction sockets is questionable unless it is combined with another material that has a space-maintaining capacity since the processing of DFDBA removes mineral content from the particles and, thus, its ability to maintain its 3-D shape. In class II extraction sockets, the use of barrier membranes, rather than hemostatic agents (i.e., collagen plug or gelfoam), may be more effective in regenerating the lost labial bone plate (**FIGURES 16A-B**).

However, when some bone loss is already present, as in class II defects, the ability to regenerate the labial plate to a more ideal coronal level may even require

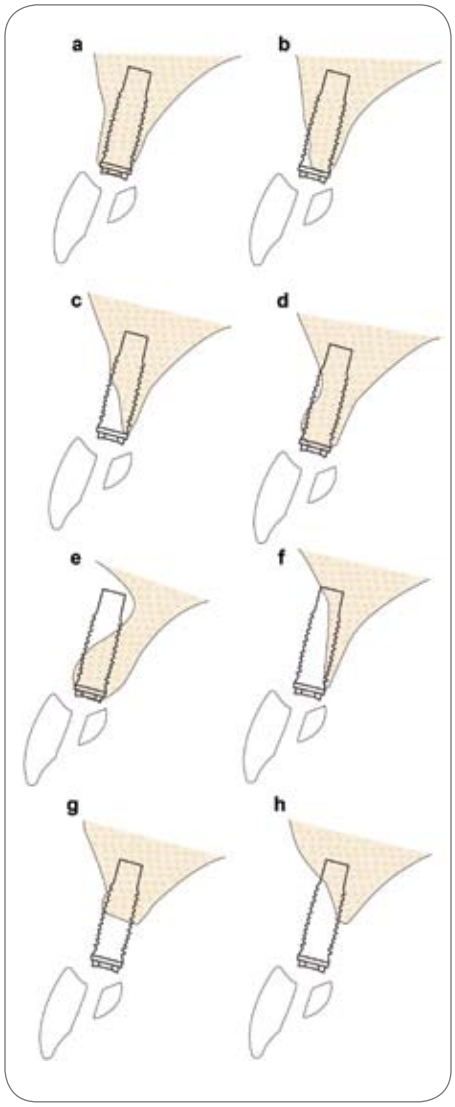

FIGURE 17. UCLA edentulous alveolar ridge classification: (a) class I; (b) class II minor; (c) class II major; (d) class III minor; (e) class III major; (f) class IV; (g) class V; and (h) class VI.

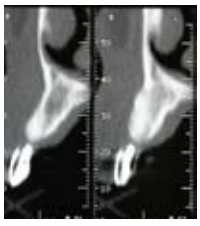

FIGURE 18. Radiographic template or guide. Gutta percha cone relates implant position to bone and tin foil outlines the facial aspect of the crown.

further bone augmentation procedures in addition to socket augmentation. Making the patient aware of the possibility for further grafting to obtain an optimal esthetic result is important in the informed consent process. This also highlights the importance of continued assessment of the planned implant site and the patient's overall goals and expectations throughout all phases of treatment. Class III extraction sockets (**FIGURE 8D**) present the most challenging situation. Regenerating the missing labial plate and soft tissue is almost impossible. The osteoconductive graft material will only prevent further invagination of the ridge but does not obviate the need for further bone augmentation.

GRAFT MATERIALS FOR SOCKET AUGMENTATION

The extraction socket graft material must have space maintaining properties. It can be osteoconductive acting as a scaffold for growing bone and allowing bone formation to be distributed more efficiently within a given space. It must also resorb at a time when the host bone can replace the material with native bone while keeping the space maintained until the bone fill is complete. Many osteoconductive materials have been reported in the literature for socket augmentation.[23]

The selection should be based on the above criteria and the planned time of entry for implant placement. If implants are to be placed in three to four months after extraction, materials with a more rapid resorption pattern should be utilized. However, after three to four months, bone regeneration will be incomplete in the center and coronal portion of the socket. Although this is not a contraindication for any specific material or to placing an implant after three to four months, the clinician should be aware of these healing characteristics. Preparing the osteotomy site for implant placement will eliminate any remnants of graft material and once the osteotomy is complete, the implant will be surrounded by bone.

If an implant is not planned initially in an extraction socket, augmentation should still be considered to reduce the possibility or degree of hard tissue augmentation that may be required in the future. However, graft materials with a slow resorption pattern should be considered. The long-term presence of slow resorbing osteoconductive graft materials will help preserve ridge contours for longer periods of time, possibly delaying alveolar ridge atrophy. Moreover, graft materials that do not resorb should not be utilized, unless dental implant placement will never be considered. With any material for socket augmentation, a barrier membrane can be used to seal off the socket or a hemostatic agent such as gel foam or collagen plug can be used to contain the material.[24]

A collagen dressing induces blood clot formation and is chemotactic for fibroblasts.[25] This property could enhance cell migration and promote primary wound coverage that are both necessary for bone growth. Primary closure of the extraction site should not be attempted as that would require vertical releasing incisions, significant undermining of the periosteum, and would move nonkeratinized unattached tissue over the crest of the ridge. Instead, a figure-of-eight suture can be placed to secure the membrane or hemostatic agent in place (**FIGURE 11**). This will help contain the graft material, and aid in regenerating keratinzed tissue.

Partially Edentulous Alveolar Ridge Assessment (UCLA Classification)

When a tooth is already missing and restoration with a single implant is planned, the diagnostic phase differs from

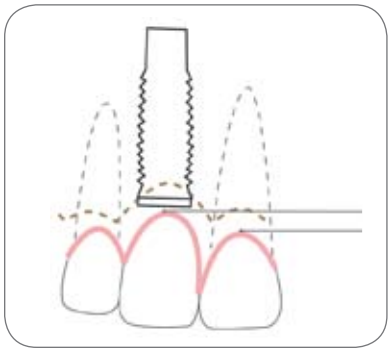

FIGURE 19. Implants placed in sites with labial bone defects may expose the implant collar and create an unesthetic gingival margin.

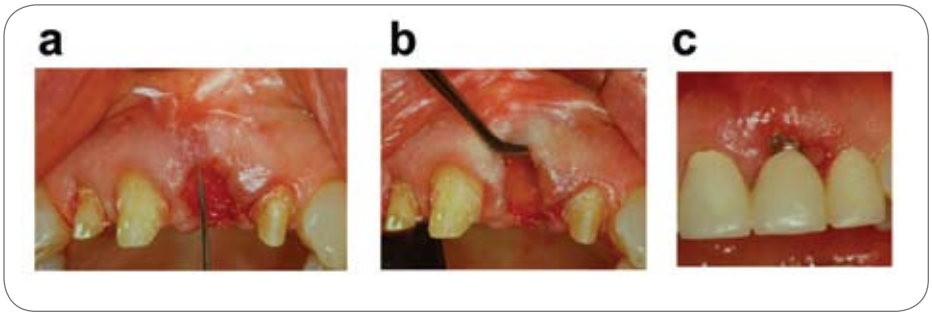

FIGURE 20. (A) Labial edge of socket is more than 6 mm below gingival margin; (b) reflection of labial tissue shows loss of labial bone; and (c) unesthetic gingival margin and implant collar exposure due to nonaugmented labial bone defect.

the clinical scenarios previously mentioned. In this case, hard and soft tissue defects are often present, either from bone loss due to periodontal or periapical disease, or from a traumatic extraction. Therefore, a classification of the partially edentulous alveolar ridge is helpful to diagnose bony defects and plan which augmentation techniques may be utilized. Here, the authors propose the UCLA classification (**FIGURES 17A-H**) of the partially edentulous alveolar ridge. Class I (**FIGURE 17A**) alveolar ridges demonstrate no vertical or horizontal deficiency, either at the crest or at the apical portion of the ridge. In class II ridges (**FIGURES 17B-C**) horizontal deficiencies are seen without any vertical bony defects. Class II is further subdivided into minor and major categories. Class II minor (**FIGURE 17B**) demonstrate minor horizontal deficiency at the crest of bone level but no horizontal deficiency at the apical level. Class II major (**FIGURE 17C**) are characterized as major horizontal deficiency at the crest of bone level, again with no horizontal deficiency at the apical level. Class III defects (**FIGURES 17D-E**) demonstrate only horizontal deficiency with normal vertical bone levels, and are again subdivided into minor and major categories. Class III minor (**FIGURE 17D**) demonstrate no horizontal deficiency at the crest level but minor horizontal deficiency at the apical level. Class III major (**FIGURE 17E**) demonstrate no horizontal deficiency at the crest of bone, but major horizontal deficiency at the apical level. Class IV (**FIGURE 17F**) reveal horizontal deficiency at both crestal and apical levels, but maintain adequate vertical bone. Class V (**FIGURE 17G**) defects are characterized by a lack of vertical bone but have adequate horizontal dimensions. Class VI (**FIGURE 17H**) are inadequate in both vertical and horizontal dimensions, where the horizontal deficiency can be at the crest and/or apical levels (as noted in class II-IV).

Horizontal Assessment

The alveolar ridge should be assessed horizontally at both crestal and apical levels. For optimal accuracy in diagnosis at this stage, a CT scan with a well-designed radiographic guide is recommended (**FIGURE 18**). This evaluation can determine the diameter of the selected dental implant, the thickness of the labial bone wall on the facial surface of the implant (**FIGURE 1A; FIGURE 18**), the need for implant position/angulation modification, and whether a parallel-wall or a tapered implant should be selected. The thickness and height of the labial bone at the crest level is very important (**FIGURE 1A**).

This bone is responsible for supporting the marginal gingiva and provides soft tissue framing.[14] Having a labial bone wall of sufficient height and thickness is important for long-term stability of harmonious gingival margins around implants and adjacent teeth. Implant patients frequently present with a labial plate that is missing or of insufficient height and/or thickness because of previous trauma, periapical or periodontal disease, or traumatic extraction. Attempts to place implants in sites with labial bone defects without hard tissue augmentation will frequently result in soft tissue recession, potentially exposing the implant collar and creating an unesthetic gingival margin (**FIGURE 19; FIGURES 20A-C**).

Vertical Assessment

The vertical height of the available bone will determine the dental implant length and the height of the labial bone wall (**FIGURE 1A; FIGURE 18**). Adequate height and thickness of the labial bone is important for long-term stability of harmonious gingival margins around implants and adjacent teeth (**FIGURES 1A-B**). For optimal accuracy in diagnosis at this stage, a CT scan with a well-designed radiographic guide is recommended (**FIGURE 18**). When evaluating the CT scan, the vertical height of available alveolar bone and the distance between the proposed crown and level of the alveolar crest can be determined (**FIGURE 18**).

Interocclusal space as well as crown to implant ratio should be taken into consideration when assessing this parameter. When a CT scan is not available, some information can still be gained from periapical and panoramic radiographs. However, magnification and distortion limitations must be realized. Additional information regarding interocclusal space and crown to implant ratio can be obtained by evaluating the guide on

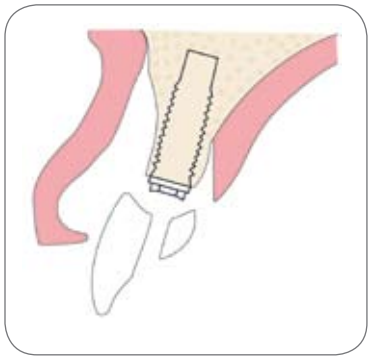

FIGURE 21. Ideal implant placement in class I alveolar ridge.

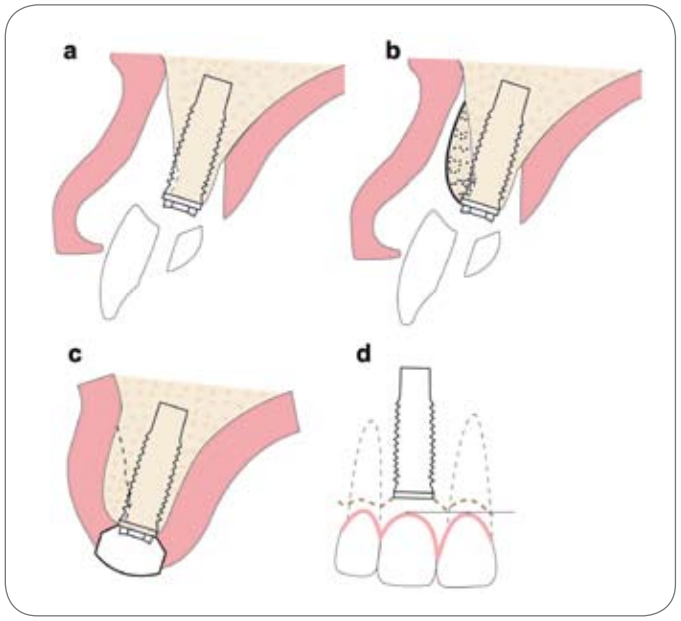

FIGURE 22. (A) UCLA class II minor horizontal deficiency at the crest; (b) Successful GBR to augment horizontal deficiency at crest; (c) adequate thickness and height of the labial plate is regenerated to cover the implant threads; and (d) the thickness and height of the labial plate are important in maintaining a harmonious gingival margin.

a model of the patient's dentition.

In addition to evaluating vertical height of available bone as described above, crest of bone at the interproximal levels of adjacent teeth and the distance between the crest of bone and future contact must be determined.[7-10] It has been shown that a distance more than 5 mm from the alveolar crest to the contact point reduces the probability of intact papillae when placing an implant next to a natural tooth[7-10] (**FIGURE 1C**). When placing an implant adjacent to another implant, the vertical level of the interproximal crest between the two implants must be evaluated[7-10] (**FIGURE 1C**). Augmentation is required to predictably maintain intact papillae if the distance between the crest of bone and the future contact point between implants is greater than 3 mm. This information can be gained with a periapical radiograph where this distance can be measured (**FIGURE 2B**).

Horizontal and Vertical Bone Augmentation Techniques for the Edentulous Alveolar Ridge

The radiographic guide or surgical guide derived from a diagnostic wax-up is used to relate the implant position/angulation to the alveolar bone and anatomical structures. If a CT scan or a tomogram is not available, the surgical guide can be used on a diagnostic model to assess implant position/angulation and to determine if horizontal and/or vertical ridge augmentation is needed.

However, soft tissue thickness obtained from a model may be misleading. In these instances, when cross-sectional radiographic images are not available, relating the surgical guide to the alveolar ridge after reflection of a full-thickness mucoperiosteal flap will be the preferred way to assess if the implant position needs to be modified or if a hard tissue augmentation procedure is needed. If the implant position/angulation needs to be modified, such a modification should be approved by the restoring dentist prior to the surgical procedure.

These issues can be discussed beforehand, when all of the diagnostic information is available so that the final outcome is not compromised from the esthetic or biomechanical aspects. Good, clear communication between the surgeon and the restorative dentist is crucial in the success of dental implants. If an implant site is noted to have a vertical hard tissue defect during the diagnostic phase, the treatment plan may include placing the implant in a more apical position. Although this is not ideal and would require either a long crown or pink porcelain gingiva, the patient may choose this option to avoid more surgical procedures to correct the deficiency. This information should be planned before the surgery and discussed between the patient, restorative dentist, and surgeon so that everyone understands the final treatment plan.

Horizontal Bone Augmentation Techniques for the Edentulous Alveolar Ridge

In a previous section of this article, the authors presented a UCLA classification for partially edentulous alveolar ridges (class I-VI) (**FIGURES 17A-H**). In this section, treatment options to deal with these specific deficiencies, either at the time of implant placement or at a separate procedure before implant placement. In UCLA class I alveolar ridges, the available bone is not deficient in the horizontal or vertical dimension for placement of a dental implant in the ideal restoratively driven position (**FIGURE 21**). Class I alveolar ridges are not very common. They are usually encountered in cases where all walls of the extraction socket are intact, when socket preservation is utilized, and when an implant is placed within three to six months.

In UCLA class II minor alveolar ridges (**FIGURES 22A-D**), minor horizontal deficiency at the crest of bone level (**FIGURE 22A**) will result in limited exposure of

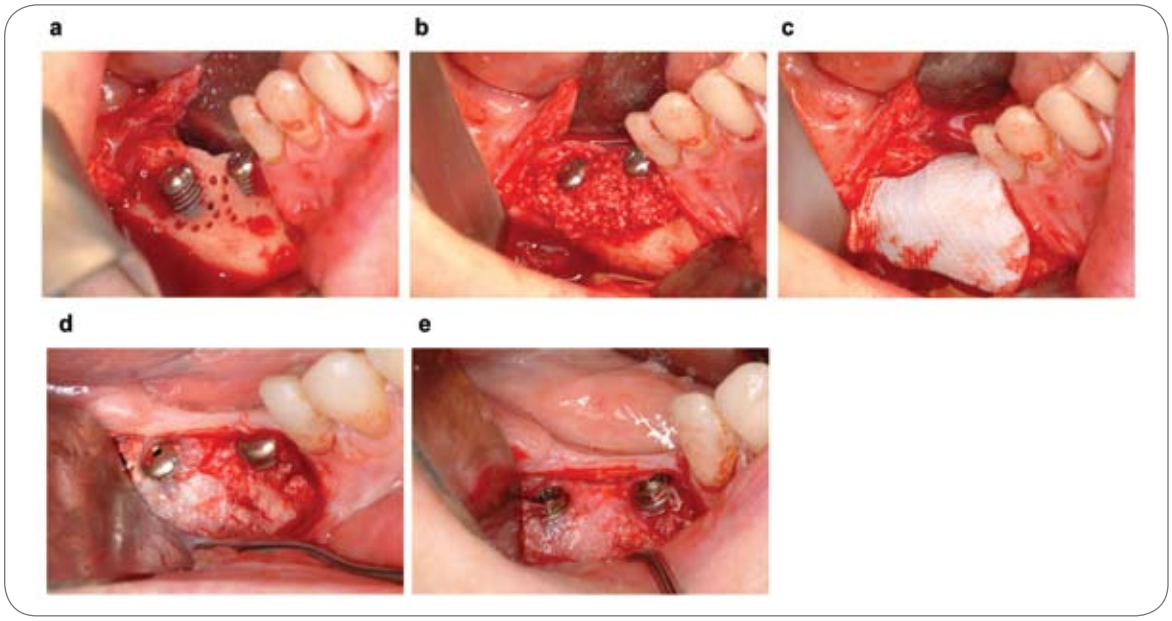

FIGURE 23. (A) Loss of bone volume at the crest requiring augmentation via guided bone regeneration (GBR); (b) particulate graft material added to increase width and height; (c) application of an occlusive membrane; (d) and guided bone regeneration completed at four months; and (e) stable implants and thread surfaces have been covered with new bone.

the coronal implant threads (one-surface exposure). Here, a GBR procedure can be attempted with simultaneous dental implant placement (**FIGURE 22B; FIGURES 23A-E**). If GBR is successful, adequate thickness and height of the labial plate will be regenerated to cover the implant threads (**FIGURE 22C**). The thickness and height of the labial plate are important in maintaining a harmonious gingival margin (**FIGURE 22D**). Attempts to place implants in sites with labial bone defects in the absence of bone reconstruction will frequently result in soft tissue recession, potentially exposing implant threads and leading to an unesthetic gingival margin. This also will be the outcome if the GBR procedure is not successful (**FIGURES 24A-D**).

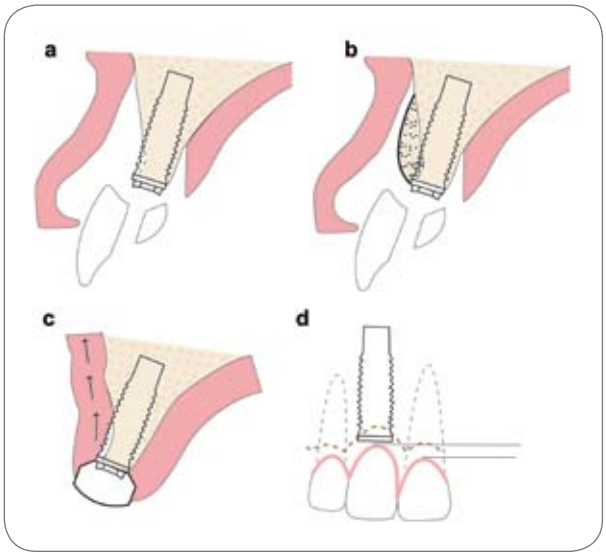

FIGURE 24. (A) UCLA class II minor horizontal deficiency at the crest; (b) UCLA class II with unsuccessful GBR; (c) UCLA class II with unsuccessful GBR will result in lack of adequate facial bone thickness and height; and (d) subsequent gingival recession and thread exposure.

In UCLA class II major alveolar ridges (**FIGURES 25A-C**), major horizontal deficiency at the crest of bone level (**FIGURE 25A**) will result in considerable exposure of the coronal implant threads (three-surface exposure). In this situation, hard tissue augmentation and simultaneous implant placement is not recommended. For more predictable results, surgical correction is recommended prior to implant placement. Various surgical techniques have been proposed to correct such bone defects at the labial aspect of implant sites. These techniques include GBR with a barrier membrane or a veneer block bone graft (**FIGURE 25B**). In both cases, four to six months of healing is required prior to implant placement. If the bone grafting procedure was successful, the implant can be placed at the ideal angulation according to the surgical guide, without any thread exposure (**FIGURE 25C**). If the horizontally deficient crest of bone is reduced to allow for an adequate width for implant placement, the implant position will be too apical (**FIGURE 26**), resulting in a long clinical crown or in an anatomical crown with added pink porcelain (pink porcelain solutions). However, if this option was chosen by the patient and restorative dentist instead of undergoing surgical procedures, it can often meet the demands of a patient, especially one with a low smile line. The size of the clinical crown, as well as the need to add pink porcelain, should be openly discussed with patients prior to

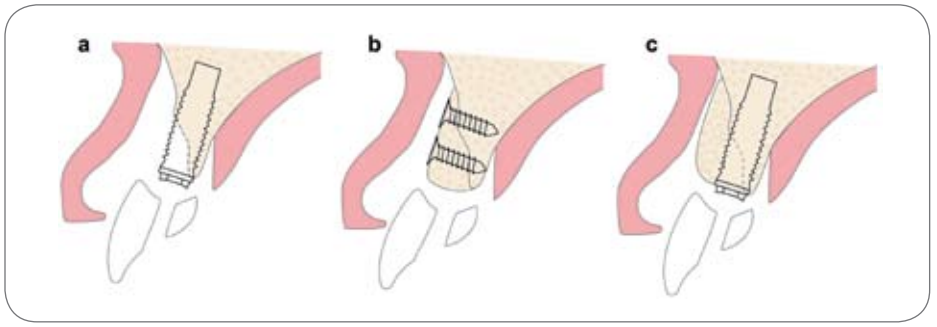

FIGURE 25. (A) UCLA class II major horizontal deficiency at the crest; (b) the use of a veneer bone graft for horizontal augmentation; and (c) implant placed at the ideal angulation according to the surgical guide after four to six months of healing.

FIGURE 26. Apical implant position resulting in long clinical crown.

FIGURE 27. (A) UCLA class III minor horizontal apical deficiency; (b) GBR and simultaneous implant placement is used for horizontal augmentation; (c) predictable results can be usually achieved with the use of barrier membranes. (D-g) Clinical pictures demonstrating (d) fenestration, (e) implant in place with apex in bone and one surface exposure; and (f-g) GBR. Note adequate horizontal dimension at the crest.

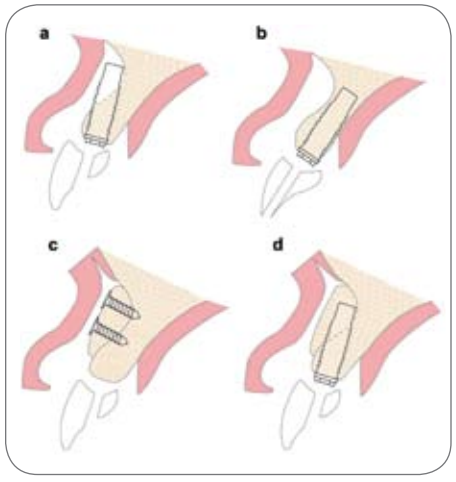

FIGURE 28. (A) UCLA class III major horizontal apical deficiency resulting in exposure of the implant; (b) a modification in implant position and/or angulation may result in housing the implant in bone; (c) the use of a veneer bone graft will allow the implant to be positioned in ideal location without modification; and (d) implant placed in ideal position four to six months after healing.

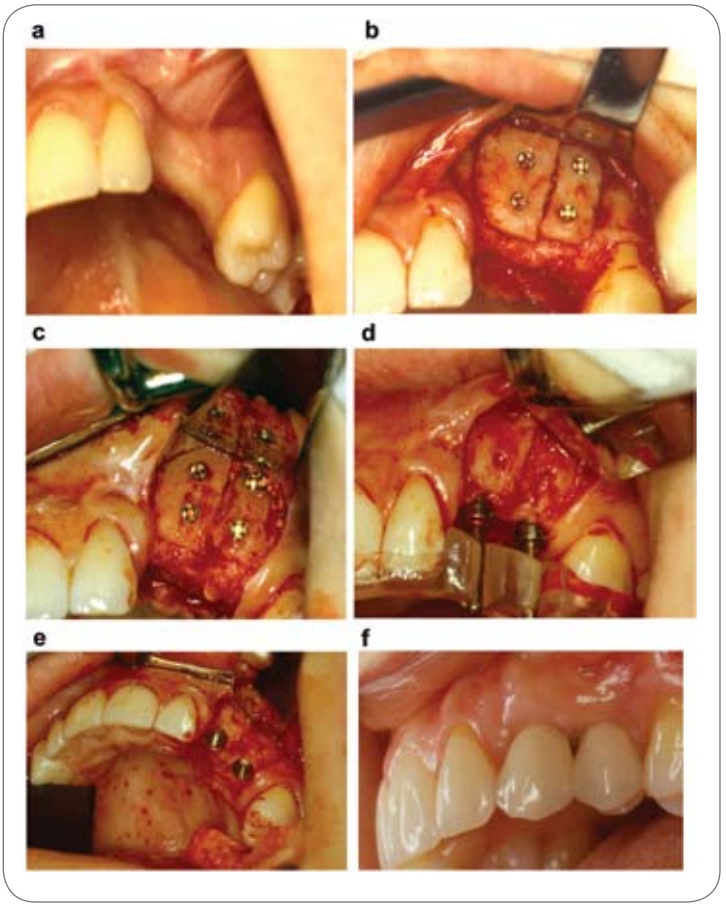

FIGURE 29. (A) Apical horizontal deficiency noted before flap reflection; (b) autogenous veneer bone graft is used to augment the horizontal deficiency; (c) results four months after graft healing; (d-e) implant site preparation and placement directed by the use of a surgical guide; and (f) results after final implant restoration.

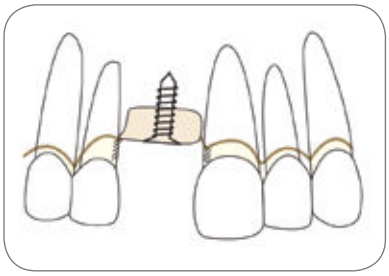

FIGURE 30. Onlay bone graft for vertical ridge augmentation.

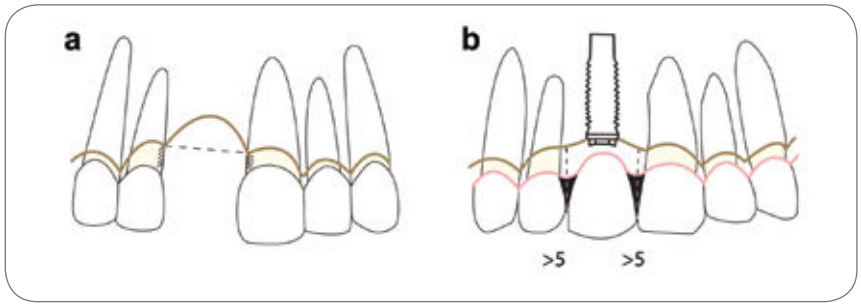

FIGURE 31. (A) The extent of vertical augmentation is limited by the level of crest of bone adjacent to teeth and (b) higher chance of loss of papilla support and the development of short peri-implant papillae.

therapy to avoid unrealistic expectations.

In UCLA class III minor alveolar ridges (**FIGURES 27A-G**), minor horizontal deficiency at the apical level (**FIGURES 27A,D,E**) will result in a limited exposure of the middle labial threads of the implant (one-surface exposure), i.e., bone fenestration defect. GBR can be attempted with simultaneous dental implant placement (**FIGURES 27B,F,G**). Predictable results can be usually achieved with the use of barrier membranes (**FIGURE 27C**).

In UCLA class III major alveolar ridges (**FIGURES 28A-D**) major horizontal deficiency at the apical level (**FIGURE 28A**) will result in a significant exposure of the middle-apical portion of the implant (three-four surface exposure). A modification in implant position and/or angulation, in the form of bodily movement or labial tipping, may result in housing the implant in bone (**FIGURE 28B**).

The need for modifying implant position/angulation has to be discussed with the restorative dentist to determine if this is acceptable esthetically and biomechanically. If it is acceptable, these implants are usually restored with a custom abutment and cement-retained restoration. If unacceptable, then hard tissue augmentation prior to implant placement is recommended. In these cases, a veneer block bone graft (**FIGURE 28C; FIGURES 29A-F**), GBR using a barrier membrane, or recombinant human bone morphogenetic protein-2 (rhBMP-2) with titanium mesh is recommended. With all of these augmentation techniques, at least four to six months healing is required prior to implant placement (**FIGURE 28D**).

In UCLA class IV alveolar ridges (**FIGURE 17F**), surgical correction is recommended prior to implant placement. Veneer block grafts, GBR, and rhBMP-2 with titanium mesh are among the techniques used for horizontal augmentation at the crestal and apical levels.

Vertical Bone Augmentation Techniques for the Edentulous Alveolar Ridge

Successful vertical bone augmentation is significantly more difficult than horizontal augmentation. Clinical situations with reduced interproximal vertical bone on adjacent teeth are especially challenging because there are currently no surgical techniques available to predictably regain lost bone on teeth. Techniques such as GBR and the use of enamel matrix derivatives (EMD) are only successful in regenerating infrabony defects, and not successful in predictably regenerating suprabony defects.[26-28] Regaining lost labial bone height is still challenging but more predictable than regaining lost interproximal bone adjacent to teeth. Block bone grafts with barrier membranes, GBR with barrier membranes, rhBMP-2 with titanium mesh, interpositional grafts, and alveolar distraction osteogenesis (ADO) can be utilized in regenerating lost labial bone and augmenting vertical bone height.

In UCLA class V alveolar ridges (**FIGURE 17G**), a significant vertical deficiency exists. When selecting a technique to augment alveolar ridges with vertical deficiencies, it is important to distinguish between techniques that can modify the interocclusal space and techniques that cannot. Most often there is an increase in the interocclusal space as a result of alveolar bone loss. Techniques such as sinus floor augmentation and nasal floor augmentation provide vertical bone height but with no effect on the interocclusal space. In the esthetic zone, the interocclusal space should not be increased if the patient's objectives are to have teeth of normal shape and size with a hard and soft tissue profile identical to the contralateral side. In those cases, techniques such as onlay bone grafts, GBR with barrier membranes, rhBMP-2 with titanium mesh, interpositional grafts, and ADO can reduce the increased interocclusal distance.

GBR WITH BARRIER MEMBRANES AND ONLAY BLOCK BONE GRAFTS

The use of titanium-reinforced-membranes, pins or screws for tenting-effect, or titanium or resorbable mesh is extremely important to maintain vertical space in GBR. Otherwise, successful vertical augmentation will not be achieved. A variety of allografts, xenografts, or alloplasts with and without particulate autogenous bone can be utilized for GBR.[29-30] Clinical studies have also shown the utilization of onlay block bone grafts for vertical bone augmentation[31] (**FIGURE 30**). In these two techniques, soft tissue closure can be challenging. Also, there is relapse and loss of volume that has to be taken into consideration.[30-32]

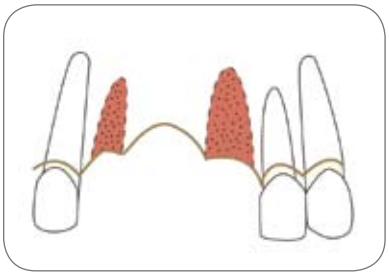

FIGURE 32. Extraction and socket augmentation.

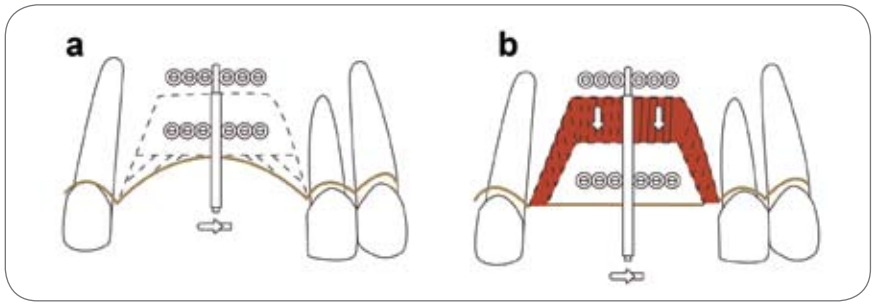

FIGURE 33. Vertical alveolar distraction osteogenesis. (A) Distraction device in place before and (b) after activation of distractor.

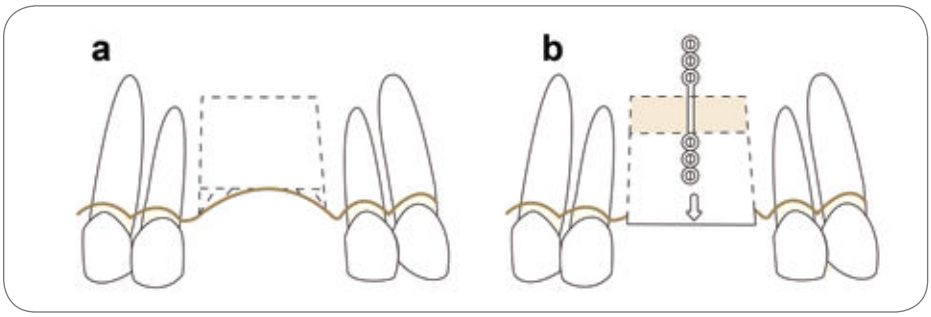

FIGURE 34. Interpositional graft for vertical ridge augmentation. (A) Osteotomy cuts and (b) interpositional graft in place.

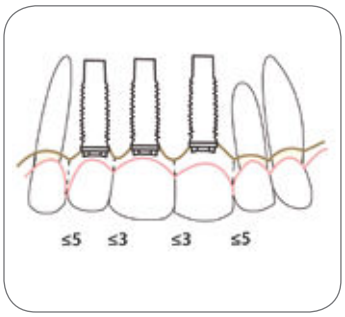

FIGURE 35. Vertical augmentation achieves a more predictable peri-implant soft tissue esthetics.

FIGURE 31A shows the extent of vertical augmentation that can be achieved with either an onlay bone graft or GBR. There is almost no effect on the vertical level of interproximal bone adjacent to teeth with a higher chance of loss of papilla support and the development of short peri-implant papillae (**FIGURE 31B**). If the crest of bone level adjacent to teeth is compromised and the distance between the future contact area and bone is increased to preclude the probability of intact papillae, the long-term prognosis of these adjacent teeth has to be considered. If the prognosis is guarded, it might be more prudent to extract these teeth with socket preservation (**FIGURE 32**) and then apply vertical augmentation techniques such as ADO (**FIGURES 33A-B**) or interpositional grafts (**FIGURES 34A-B**) to be able to achieve a more desirable esthetic effect (**FIGURE 35**). These issues require extensive discussion before any extractions are performed because once implants are placed, they cannot be changed. Therefore, patients should be aware of limitations of adjacent teeth with existing bone loss and consequences of treatment plans that are not comprehensive.

ALVEOLAR DISTRACTION OSTEOGENESIS

ADO is a hard and soft tissue augmentation technique that utilizes gradual and slow traction between two vascular bony surfaces[33-34] (**FIGURES 33A-B**). It consists of three sequential periods, the first being the "latency period." This period from bone division (i.e., surgical separation of bone into two segments) to the onset of traction and represents the time allowed for callus formation. The second is the "distraction period," the time when gradual traction is applied to bone segments and new tissue (regenerate tissue) is formed. The duration of this period depends on the magnitude and frequency of distraction. The distraction rate is usually 1 mm per day. The third is the "consolidation period." Consolidation of the distraction regenerate after the traction forces and the segment movement are discontinued. The duration of this period is from three to four months, depending on the age of the patient. To maximize the extent of vertical augmentation, the cross-hatched edges of the transport segment, shown in **FIGURE 33A**, are trimmed.

Also in vertical distraction, a more horizontal dimension at the crest of the ridge can be achieved by reducing and flattening a sharp-edged ridge. Clinical studies demonstrated a relapse of about 20 percent in ADO. This has to be compensated for by overcorrection.[35] When considering ADO, the dimensions of the distraction device exceed the size of the single-tooth bone segment. Therefore, in the single-tooth situation, an interpositional graft is recommended for vertical augmentation.

INTERPOSITIONAL GRAFT

An interpositional graft is a vertical bone augmentation technique, utilizing a bone graft sandwiched between

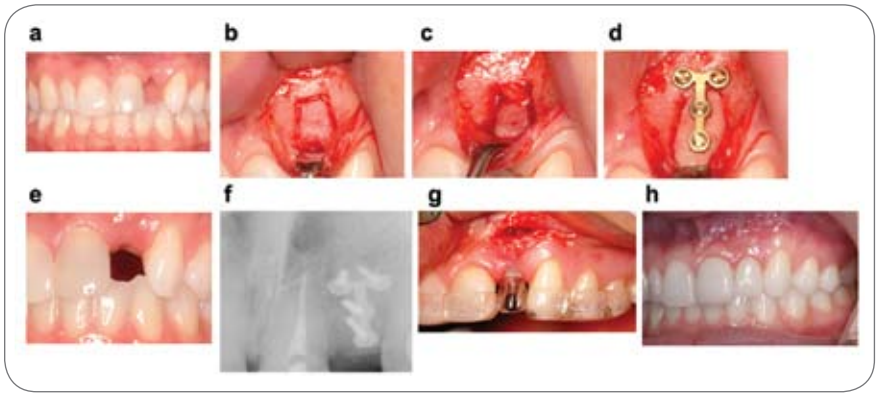

FIGURE 36. (A) Loss of alveolar height and gingival contours; (b) osteotomy of alveolar segment to be mobilized inferiorly; (c) autogenous bone sandwiched between osteotomy and basal bone; (d) fixation of bone segment using small fixation plate; (e) four months postinterpositional graft showing improvement in soft tissue height and contours; (f) periapical radiograph showing a well-healed bone graft; (g) placement of implant using a surgical template. The horizontal incision is used to remove the fixation plate; and (h) one-year post loading with definitive prosthesis.

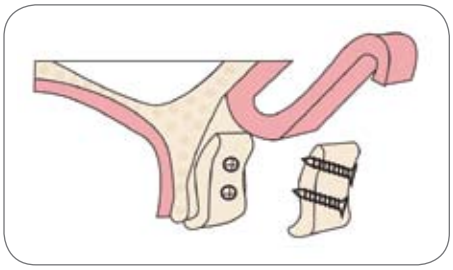

FIGURE 37. Saddle graft. (Modified from Palacci and Ericsson.[43])

basal bone and the osteotomized alveolar bone[36] (**FIGURES 34A-B; FIGURES 36A-H**). Instead of a free bone graft at the crest of the ridge in onlay grafts, interpositional grafts maintain vascularity to the crest of the ridge by moving the bony segment coronally. To maximize the extent of vertical augmentation, the cross-hatched edges of the transport segment shown in **FIGURE 34A** are trimmed. A more horizontal dimension at the crest of the ridge can be achieved by reducing and flattening a sharp-edged ridge.

RHBMP-2 WITH TITANIUM MESH

rhBMP-2 is an osteoinductive protein that attracts undifferentiated mesenchymal cells from the circulation and promotes their differentiation into osteoblasts to induce bone formation.[37-39] rhBMP-2 adsorbed onto a collagen sponge as a carrier has been studied both in localized alveolar ridge defects and maxillary sinus floor augmentation.[40,41] Here, rhBMP-2 soaked sponges are placed over the deficient ridge and covered with titanium mesh to maintain the space and prevent soft tissue collapse.

PORCELAIN SOLUTIONS

Porcelain solutions as a nonsurgical mean of vertical augmentation can be used. Patients with medical problems that may preclude significant bone

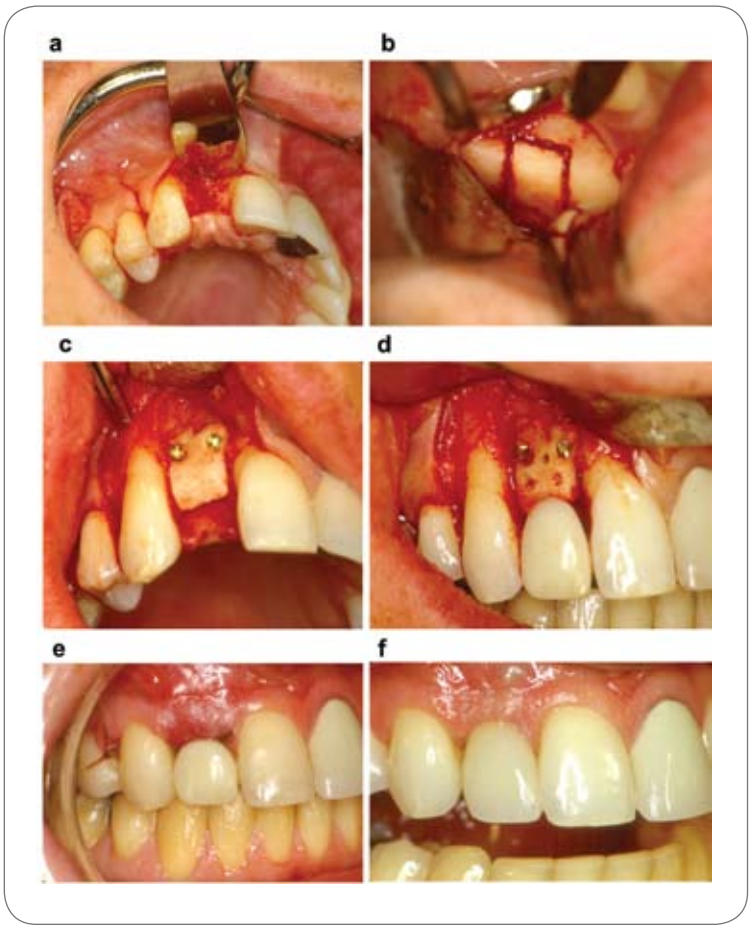

FIGURE 38. (A) Horizontal and vertical bone deficiency; (b) use of autogenous saddle graft harvested from the mandibular ramus; (c) saddle block graft is secured with fixation screws; (d) vascular channels created; (e) soft tissue closure; and (f) four months post-grafting showing improved contours of labial gingival tissue.

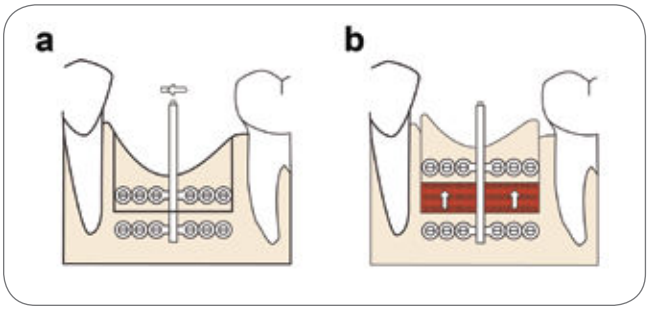

FIGURE 39. Vertical alveolar distraction osteogenesis. (A) Distraction device in place before and (b) after activation of distractor. (Modified from Saulacic.[44])

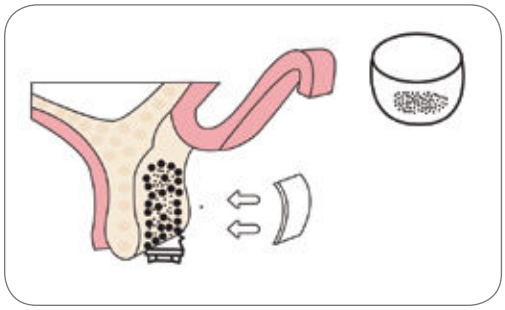

FIGURE 40. Guided bone regeneration. (Modified from Palacci and Ericsson.[43])

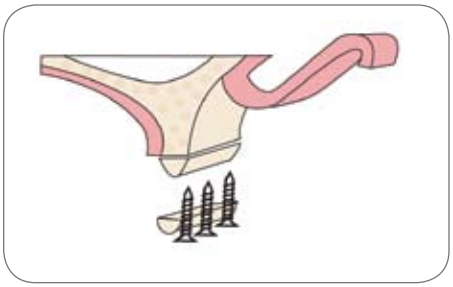

FIGURE 41. Onlay graft. (Modified from Palacci and Ericsson.[43])

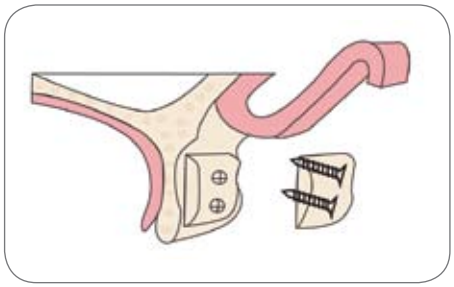

FIGURE 42. Veneer graft. (Modified from Palacci and Ericsson.[43])

grafting procedures, or patients who do not want to have these additional surgeries, may be candidates for this therapy. These treatment options should be discussed between the restorative dentist, surgeon, and patient to make sure all understand the overall treatment objectives before choosing this therapy.

Vertical and Horizontal Bone Augmentation Techniques for Partially Edentulous Alveolar Ridges

In UCLA class VI alveolar ridges (**FIGURE 17H**), surgical correction is recommended prior to implant placement. Various surgical techniques have been proposed to correct such bone defects at future implant sites. Among these techniques GBR using barrier membranes, rhBMP-2 with titanium mesh, saddle grafts (**FIGURE 37; FIGURES 38A-F**), and ADO are utilized. A healing period of four to six months is required prior to implant placement when GBR, rhBMP-2, or a saddle graft is utilized. A vertical distraction device (**FIGURES 39A-B**) can be used for vertical and horizontal augmentation by reducing a knife-edge ridge to a wider platform prior to distraction.

If the horizontal dimension is severely compromised, it is more predictable to re-establish the lost vertical dimensions first before correcting the horizontal deficiencies when surgical procedures are staged. ADO should be followed by a veneer block graft to correct for the horizontal deficiency.

Definitions and Terminology

Autogenous bone graft: Bone is harvested from one anatomical site and transferred to another anatomical site in the same individual.

Allograft bone: Bone is harvested from another host of the same species, and processed and sterilized by a tissue bank. Allografts can be frozen, mineralized freeze-dried bone allograft (FDBA), or demineralized freeze-dried bone allograft (DFDBA).[42]

Xenograft bone: Bone is harvested from a host of a different species from the recipient. Bovine source is the most common, where it is usually deproteinated thermally or chemically.

Alloplasts: Bone substitute is a synthetic material that does not contain organic matrix.

Osteogenesis: Bone formation from osteocompetent cells in the donor bone.

Osteoconduction: Bone formation along a scaffold from the host's osteocompetent cells.

Osteoinduction: Bone formation from the differentiation and stimulation of mesenchymal cells by bone inductive proteins.

Bone morphogenetic protein (BMP): A growth factor produced by osteoblasts and stored in bone matrix. When released, it induces the differentiation of primitive mesenchymal stem cells into the osteoblastic lineage. Human bone morphogenetic protein is produced by recombinant DNA technology.

Enamel matrix derivative (EMD): A protein extract of embryonic enamel matrix (amelogenin) which is thought to induce mesenchymal cells to mimic the processes that take place through the development of nascent root and periodontal tissue. This protein is harvested from developing pig embryo teeth.[42]

Guided bone regeneration (GBR): (**FIGURE 40**) Technique to regenerate bone by inhibiting soft tissue proliferation with an occlusive barrier membrane, allowing for bone formation.

Onlay graft: (**FIGURE 41**) Bone augmentation technique utilizing the placement of a graft over the crest of bone to increase the vertical dimension.

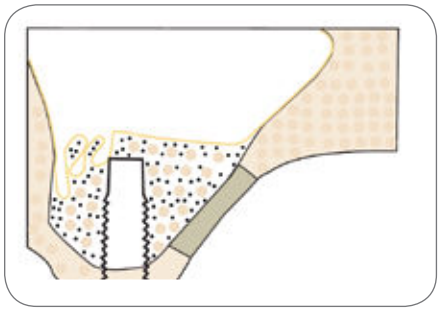

FIGURE 43. Inlay graft, maxillary sinus floor augmentation. Gain in vertical dimension does not modify the interocclusal space.

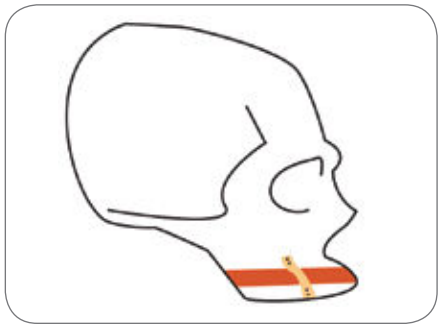

FIGURE 44. Interpositional graft.

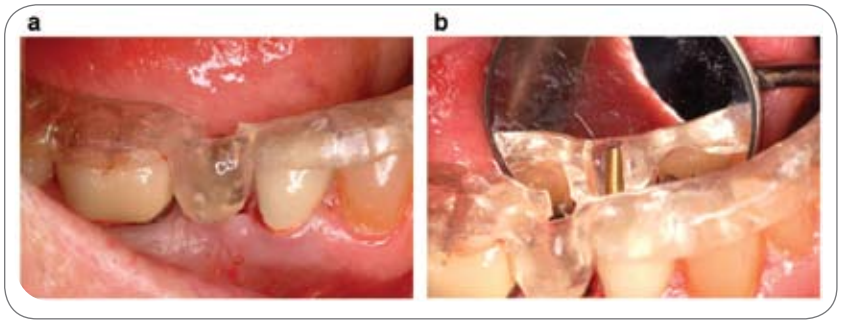

FIGURE 45. (A) The surgical template or guide dictates drilling position/angulation and directs implant placement in three dimensions and (b) lingual view showing a directional indicator placed in the osteotomy site.

Veneer graft: (**FIGURE 42**) Bone augmentation technique utilizing the placement of a graft on the facial aspect of bone to increase the horizontal dimension.

Saddle graft: (**FIGURE 37**) Bone augmentation technique utilizing the placement of a "J-" or "L-" shaped graft on and over bone to increase the vertical as well as the horizontal dimension.

Inlay graft: (**FIGURE 43**) Bone augmentation technique utilizing the placement of a graft inside a bony cavity to increase the vertical dimension. Examples are sinus augmentation and nasal floor augmentations.

Interpositional graft: (**FIGURE 44**) Bone augmentation technique sandwiching a bone graft between basal bone and the osteotomized alveolar bone to increase vertical dimension. The osteotomized segment maintains blood supply via the lingual or palatal mucoperiosteum.

Alveolar distraction osteogenesis (ADO): (**FIGURE 39**) Bone and soft tissue augmentation technique utilizing gradual and controlled tension on two vascular surfaces created by an osteotomy. The osteotomy separates the alveolar bone (transport segment) from the basal bone. Osteogenesis begins with the development of a callus, which forms new bone as it is stretched or placed under tension. The transport segment maintains blood supply via the lingual mucoperiosteum. ADO can increase the vertical and/or the horizontal dimension depending on the direction of traction (distraction vector).[42]

Radiographic template or guide: (**FIGURE 18**) A guide, obtained from a diagnostic wax-up, to be worn during CT scan, panoramic or periapical radiograph to evaluate the proposed implant position to the alveolar bone, radiopaque tooth pontics, and underlying anatomy.[42]

Surgical template or guide: (**FIGURES 45A-B**) A guide, obtained from a diagnostic wax-up, used to assist in the preparation for and the placement of implants.[42] It dictates drilling position/angulation and directs implant placement in three dimensions. The drilling channel directs the buccolingual and mesiodistal position while the gingival margin directs the apical-coronal position. Often, the surgical guide is the same as the radiographic guide, but may be modified based on the information from the radiograph obtained. ■■■■

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Billing Blues

My father always felt that "For Services Rendered" was a vast conspiracy — right or left, he wasn't sure which — to cover up charges for things that never happened.

Robert E. Horseman, DDS

ILLUSTRATION BY CHARLIE O. HAYWARD

I remember the red gingham oilcloth on the kitchen table. (Oh, no! Not another nostalgia piece! What's up with this preoccupation with the Old Days? — *ed*.)

Sorting through the bills stacked before him on the first of every month is my father, wearing the same frowny expression he uses when checking the dipstick on our Ford Model A.

"For Services Rendered" ... "What the #**@* does that mean?" I hear him fuming audibly from three rooms away where I am busy solving basic quantum physics problems with my No. 2 Erector Set.

"Ernie! Please — not in front of the children," my mother, who resembles an early version of June Cleaver, only without the pearls and sling heel pumps, gently admonishes from her position at the kitchen sink. She is busily engaged assembling tuna casseroles to ship to starving Armenians who eventually have to file protests with the American Embassy in Yerevan.

My father always felt that "For Services Rendered" was a vast conspiracy — right or left, he wasn't sure which — to cover up charges for things that never happened. When a justification of the charges was eventually wrung from the guilty party submitting the bill, he would triumphantly shout to my mother, "Well, why in the #*&$!# didn't they just say so!"

I wonder how Pop would react today, some 75 years later, as I scanned the 10-page billing I received from Verizon Wireless (motto: More bars than Bourbon Street and the Las Vegas Strip combined). Somehow, during that length of time, federal and state edicts have convinced companies to delineate on paper every transaction, real or imagined, initiated or received during the last month with surcharges for especially annoying ring tones.

Sensing this may arouse customers to revert to the less expensive two-cans-on-a-string technique, or even limit sharing their most vapid thoughts with others,

CONTINUES ON 901

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DR. BOB, CONTINUED FROM 902

utility companies have defensibly taken to ratting out the government. This is like the petroleum industry that suggests the real cost of a gallon of gas is only 4 cents, but state, county, city, federal, and galactic taxes have unconscionably boosted the cost of a gallon to rival that of a Ritz-Carlton cheeseburger.

Not our fault, they demur, then proceed to list throughout the voluminous bill that comes with a thoughtfully provided return envelope with the little square cautioning the post office will not accept your money without a stamp that changes price about as often as airline fare, except that never in recorded history has the price of a stamp ever gone down. Oh, sorry! The list — well, here's just a few on Verizon's bill:

- Package residence line charge
- Interstate subscriber charge
- Federal excise tax
- Funding to support the Public Utilities Commission (note: The PUC does not count as a dependent on your 1040 IRS form.)
- 911 state tax (I thought that was New York)
- Temporary surcharge as allowed by the PUC (that was placed 150 years ago)
- California relay service and communications devices fund
- California Teleconnect fund surcharge

Rounding off the first section is the California High Cost Fund-A and the Federal Universal Service fee. In between a couple of those ambiguous charges are the CHCF-B and the CASF charges, but they are 9 cents combined, so are obviously a bargain only a cheapskate would dispute.

Nobody knows what any of these entries represent. This is supposed to be a telephone bill, not an unabridged history of telephonic communications! However, this is the answer to people like my father who disliked the "For Services Rendered" distillation. These items are not to be questioned unless you want to be placed on hold for 30 minutes because "your call is important to us."

A little further down the list, almost hidden behind the "Inside Wire Maintenance charge," is a conciliatory line stating that I am blessed with "unlimited ZUM." I don't know what this is, but apparently Verizon has lots of it. I think I would have recalled if somebody in a position of authority had asked me if I wanted ZUM, to which I would have replied, "No, thanks, I just had ZUM."

The point is, if you have any influence over the person issuing your monthly dental statements, I urge you to see if you can get away with the return to the simpler "For Services Rendered." Chances are you won't get any more complaints than for a listing of No. 14, PFM crown, high noble, porcelain margin, occlusal staining, Septicane surcharge, RDA's optional Starbuck's in-house lunch fund.

You might want to try this on the insurance companies first; they are always looking for ways to streamline their operation. ■■■■