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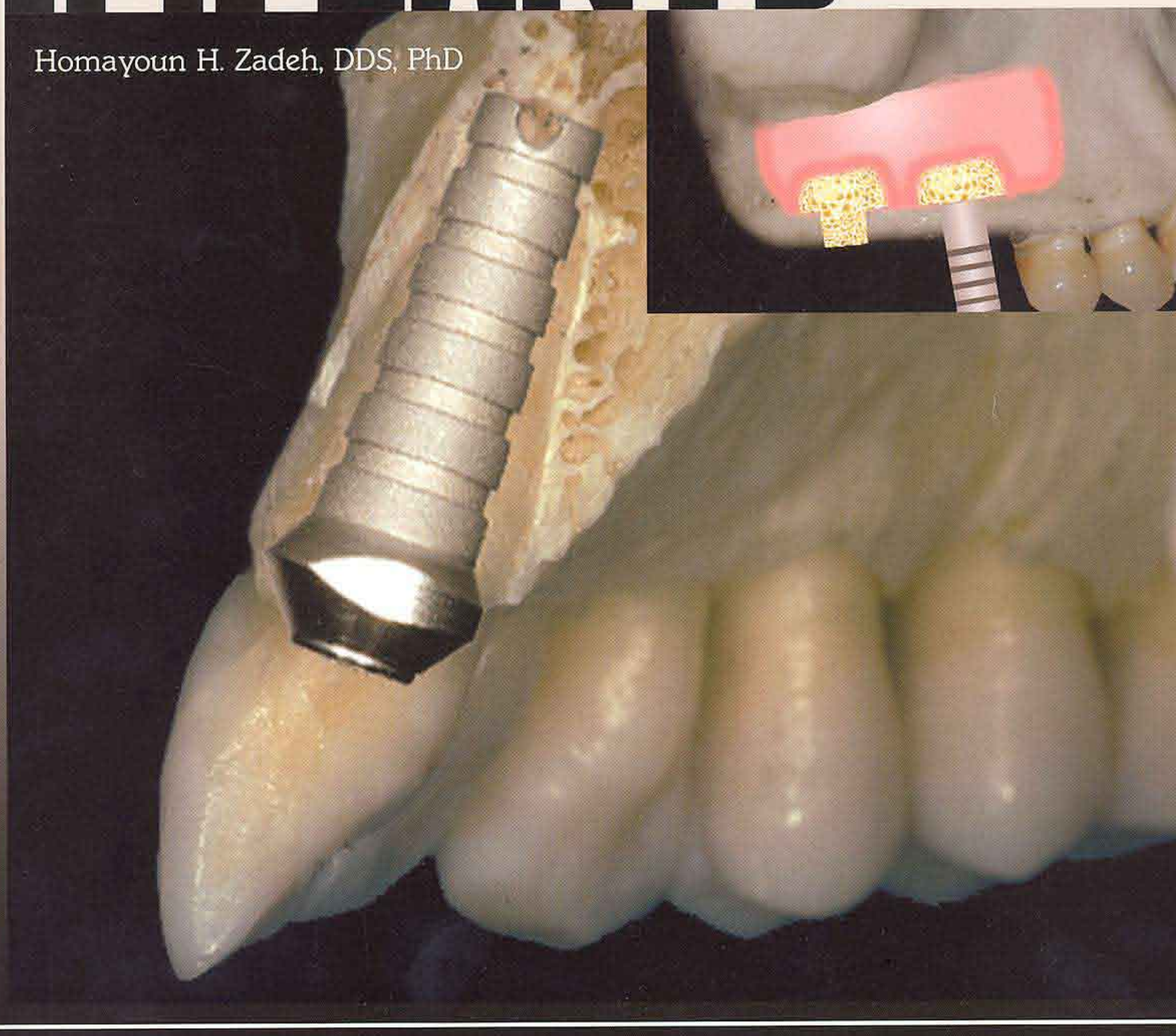

Homayoun H. Zadeh, DDS, PhD

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OF THE CALIFORNIA DENTAL ASSOCIATION
Journal

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DEPARTMENTS

FEATURES

Alan L. Felsenfeld, DDS

Out With the Old ... In With the Old

In 1715, Henry the VI was the king of France and had the misfortune of dying. It is purported that his captain of the guard came out on the balcony of the palace and stated before the throngs of well wishers that the "The king is dead. Long live the king."

Now, in all candor, I have had a difficult time through the years understanding exactly what that classic saying means. There are two schools of interpretation I can offer. The first is that the present king has died but we should not forget who he was or for what he stood. Jack Conley, I am very happy to report, is not dead but has recently retired as the editor of the *Journal of the California Dental Association* after 22 years in the position. One would have to assume that tenure of that length sets some sort of record in the annals of editorship. Certainly that would be a reasonable guess for state dental journals or even any science publication. In commemoration of his laudable and lengthy service to our organization, the House of Delegates appointed him editor emeritus, a newly established and well-deserved position to honor his dedication and service to us all.

The *Journal* was first published in 1973 with the amalgamation of the then-(Northern) California Dental Association with the Southern California State Dental Association. In the formative years, there were four individuals who served as the editor, none of whom lasted more than 36 months. The Board of Trustees selected Jack as the editor in 1983 and history began. For 22 years, the *Journal* has grown to be a well-respected publication that serves the members of the California Dental Association, as well as other individuals, very well. It has the second-largest circulation of any dental publication. During the time Jack was editor, the publication grew in size and quality of the articles. It has won numerous national and local awards for its merit. The *Journal* has become a solid pillar of our association.

Arguably, one could interpret the expression about the king to suggest that the king has died now let us turn our loyalty to the new king. That would be me — sort of. The process of selection of the new editor was laborious. A select committee of the association was appointed, and many very well-qualified and experienced individuals applied for the position of editor. Each applicant had to submit the requisite letters of recommendation and curriculum vitae. In addition, a sample of previous writings was reviewed. From the larger group, a smaller group was chosen to be interviewed. Prior to that process, the finalists were told to write an editorial with a short deadline on a given subject. The committee then selected the editor, and the Board of Trustees approved the appointment.

The work of the editor has three phases to it. The first and obvious one is to publish a quality *Journal* on a monthly basis and on time. As I have been indoctrinated into the process, let me assure you all we have an excellent staff who works extremely hard and allows me the pleasure of problem solving only when it comes to the publication. Secondly, the editor must provide editorial topics in each *Journal*. This is a seemingly overwhelming task, but if one considers that Dr. Conley did more than 200 editorials, then it is doable. I will be assisted ably by Dr. Steven A. Gold, our associate editor, in this area. The last, and most time consuming, part of the position is that the edi-

I would like to hear from the readership as to what they like and expect on a monthly basis.

tor is a member of the Board of Trustees and Executive committee, ex-officio, without the right to vote. This involves not only a tremendous time commitment but also an understanding of the issues facing the organization. To a certain extent, if an editor is reappointed in perpetuity, as was the case with Jack Conley, then they can serve as the historian of the board as well.

I am likely to take some positions that I called controversial in discussion with my friends but was advised to call provocative.

One has to wonder why I was appointed and I think about this often. This is not my first time being involved in organized dentistry at a high level. Throughout my 30 years in dentistry (I, too, am not a youngster), I have been committed to doing for all of our colleagues in the political and administrative facets of our profession. I have been active not only in my two components and the California Dental Association, but also in my specialty organization. I have been a delegate in many houses, served on local, statewide and national committees including chairing several of them. Having served in the chairs and on boards at all levels, I have a variety of perspectives. I have been in private practice and presently am in a full-time academic position. This is not intended to be braggadocio, rather to show that I have been around, have a variety of experiences, and hopefully can understand the issues facing dentistry in our ever-changing environment.

One of the other concerns with becoming editor is that with the present structure of the *Journal* there is no stair-step progression to the top. The editor starts Day One as the top official in the *Journal*, albeit with superb staff support, but with a dearth of experience in actually managing a publication of this size and importance.

Many of my colleagues have already contacted me and were curious as to the changes that I plan to make to the *Journal*. When asked a similar question in the interview, I responded that change for the sake of it without cause is not a reasonable option. We have a *Journal* that works well as it is. Can it be improved? Of course. Will there be changes? Possibly, but they will be gradual. I would like to hear from the readership as to what they like and expect on a monthly basis. As I think through my editorial topics, I am likely to take some positions that I called controversial in discussion with my friends but was advised to call provocative. If we can provoke a thought process or generate a response of letters to the editor for and against any specific issue, then we will improve the value of the *Journal* to our members. I can be reached via e-mail at the CDA headquarters at AFelsenfeld@cda.org. I would appreciate letters to the editor, suggestions for how the *Journal* can better serve our readership, topics you might like to see in dedicated or topical *Journals*, and articles that you the readers write and would like to have published. With respect to the latter area, recognize that this is a peer-reviewed journal and that all articles need to meet our standards.

One thing is for sure. I have already received two death threats regarding the possibility that I might stop publishing Dr. Bob's column. That will not happen. Many of us, myself included, start reading the issues from the back to see what is on his mind then going to the front for the scientific part. Dr. Bob will continue for as long as he is willing to write his column.

So am I the new king? No, not hardly. I suppose that you could say I might be the prince or possibly heir to the throne. For now, I have a steep learning curve and will work hard to maintain the high level that Jack Conley showed for the past 22 years. I am delighted to be the editor of such a prestigious publication and will strive to serve our organization and dentistry as well as I can. CDA

Illustration: Polly Powell

Study of the Role of Genetics and Periodontal Disease Under Way

Why certain people experience periodontal disease differently than others and why some have better success when responding to treatment is the subject of a new, three-year study by scientists at Columbia University Medical Center.

Columbia's research to eradicate periodontitis in these patients and have a clearer understanding of how gum disease develops also allows the development of pharmacologic therapies geared toward a person's own genetic predisposition for response.

The leading cause of tooth loss in adults is periodontitis. The disease occurs when infected gums are left untreated and inflammation spreads to ligaments and bone-supporting teeth. Even with treatment, some patients, based on their genetics, will see the deterioration of their gums and eventually become edentulous.

The study, funded by the National

"We intend to identify the molecular basis of the wide spectrum of responses to periodontal bacteria, and use this information to reduce the risk of periodontitis and develop new, more-targeted therapies."

Panos N. Papapanou, DDS, PhD

Institute of Dental and Craniofacial Research, will be used to determine whether various forms of periodontitis can be classified based on gene expression in swollen gums.

"The current system for classifying periodontal disease does not have a solid, pathobiology-based foundation," said Panos N. Papapanou, DDS, PhD, the principal investigator on the project.

"We intend to identify the molecular basis of the wide spectrum of responses to periodontal bacteria, and use this information to reduce the risk of periodontitis and develop new, more-targeted therapies," said Papapanou, who also is professor and chair of the Section of Oral and Diagnostic Sciences and director of the Division of Periodontics, Columbia University School of Dental and Oral Surgery.

Periodontitis is classified into two groups, aggressive and chronic, categorized based on clinical signs following oral health and medical history. Differentiating these two groups can be hard since the clinical signs of both can be almost identical. Response to typical therapeutic procedures can fluctuate greatly. Both types of periodontitis are characterized by deep periodontal pockets and inflamed gums. Therapy typically involves the cleaning of root surfaces and periodontal pockets as well as gum surgery and associated antibiotics.

The patient's immunoinflammatory response to the bacterial challenge is thought to determine the extent, severity and type of periodontitis. It is this response that is believed to have a solid genetic component. Papapanou and his team will examine gene expression signatures to define the various subtypes of periodontitis to better understand the molecular processes entailed in each subtype.

"In addition to providing insights into the pathobiology of periodontitis, this research will provide a wealth of data on the basic host responses to infection," said Paul Pavlidis, PhD, co-principal investigator of the study and assistant professor in the Columbia University department of Biomedical Informatics and the Columbia Genome Center.

The research takes advantage of contemporary gene expression profiling technology, such as those used to study the behavior and prognosis of specific cancers. Papapanou and his team will study 120 patients — 60 with chronic periodontitis and 60 with the aggressive version. Inflamed tissue samples from the patients will be analyzed to identify local patterns of gene expression in swollen gums. It also will be used to develop a new classification scheme based on likenesses in gene expression signatures.

Oral Piercings and Their Clinical Complications

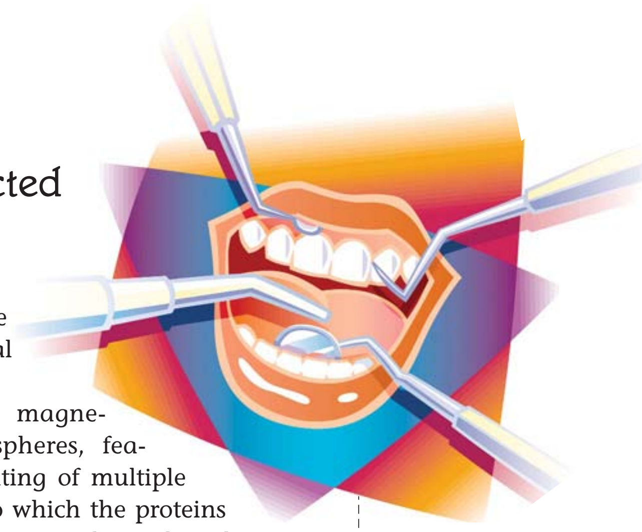
Intraoral jewelry and piercing of the perioral and oral tissues, which has increasingly gained popularity among young adults, teens and even children, poses great risk to one's oral health.

Renee Fraser, DDS, in the spring 2004 issue of *Journal of the Macomb Dental Society* (Ill.), discussed potential pathological conditions following an oral piercing. Conditions with tongue piercing may range from mild pain and swelling to life-threatening secondary infections resulting in cellulites and airway obstruction. Perioral and oral piercings can increase salivary flow, tooth fractures, restoration and fixed porcelain prostheses damage, scar formations, metal hypersensitivity reactions, periodontal disease, and speech impediments. Devotees of such piercings also may accidentally ingest or aspirate the jewelry, which then poses great risk to digestive and respiratory organs.

In the article, Fraser cited her experience in treating a 9-year-old girl recently. The girl had used a magnetic earring as a nose ring and accidentally inhaled the ornament portion of the jewelry. Fraser was required to utilize deep sedation in order to remove it.

Fraser also noted that the American Dental Association and the American Academy of Pediatric Dentistry oppose the practice of piercing perioral and intraoral tissues.

Periodontal Bone Loss May Be Detected by Chairside Saliva Test



An alternative to traditional radiographic and periodontal pocket probing exams to determine periodontal bone loss is being developed by dental researchers at the State University of New York at Buffalo.

The method, a quick, chairside saliva test, uses protein biomarkers associated with bone destruction found in fluid in the gingival crevice.

The researchers, according to a UB press release, are trying to determine if these same biomarkers are present in the saliva, particularly since collecting the fluid from the gingival crevice in adequate amounts sufficient for analysis can be time consuming.

Should the biomarkers be present in the saliva in amounts enough to measure, the method could lead to development of a one-step saliva test that may be utilized during dental exams to determine if patients have active bone loss because of periodontal disease.

Partially magnetized microspheres, featuring a coating of multiple antibodies to which the proteins can bind, are inserted into the saliva samples, captured with a magnet, which permits the biomarkers to be concentrated and analyzed. The study will utilize saliva samples from the UB Women's Health Initiative Vanguard Center, where baseline periodontal status and oral health information in participating women are being tracked for five years.

The National Institute of Dental and Craniofacial Research is supporting the research with a two-year grant.

Hormones May Affect Oral Health

Since pregnancy can cause soft tissue changes in women due partly because of hormonal variations, it is important for women to be mindful of their oral health.

Many women may experience some type of gingivitis, which tends to surface mostly in the second trimester. Women who have gum disease may be more likely to have premature babies with low birth weights, studies have shown. Developing pregnancy granulomas and dry mouth can also pose other health problems.

"To ensure that you have good oral health, ideally you should contact your dentist when planning to become pregnant or as soon as you find out if you are pregnant," said Barbara J. Steinberg, DDS, FAGD, in the August/September 2004 issue of the American General Dentistry's magazine, *AGD Impact*.

"Your dentist will examine you to determine what type of treatment you require and the best times to provide the care," she said.

Steinberg recommended women take charge of their oral health by brushing at least three times a day with a fluoride toothpaste and flossing thoroughly. Good nutrition also is important for the mother and baby's health.

"Your dentist will determine how frequently you need to be seen throughout your pregnancy in order to maintain optimal oral health," Steinberg said.

American Indian Health Website Launched

A new website that addresses the health concerns of the estimated 4 million Americans who claim Alaska Native of American Indian ancestry has been established.

Studies have shown that Native Americans are nearly three times as likely to have diabetes as non-Hispanic whites of the same age. Additionally, American Indians are at greater risk for suicide, alcoholism, pneumonia, tuberculosis and influenza than the average population. The site, American Indian Health, can be found online at http://americanindianhealth.nlm. nih.gov.

The website provides information to this population on special needs such as health and medical resources including consumer health information, research results links to other pertinent websites and traditional healing resources. Data is from other National Library of Medicine resources such as Medline Plus and PubMed.

"The National Library of Medicine is interested in reaching out to the population with special needs," said Donald A.B. Lindberg, MD, library director. He added that the National Library of Medicine has attended powwows in the past and has made health information available during those events.

Based on the idea that specific populations have different health needs, the National Library of Medicine also created several dedicated sites including those living in the Arctic and far north, senior citizens, Asian Americans and Spanish-speaking Americans. Those sites are available at http://www.nlm.nih.gov/databases.

Exhibit Highlights International Dental Posters

A new poster exhibit, "The Art of Smiles: Posters Around the World," is on display at the Saccente Gallery at the Samuel D. Harris National Museum of Dentistry in Baltimore, Md.

Photo: Dr. Samuel D. Harris National Museum of Dentistry

The displays include the museum's collection of rare dental advertising posters from the United States and Europe. The posters were used to advertise dental products ranging from toothbrush liquids, powders and toothpaste to mouthwashes, toothbrushes and pain relievers from the 1900s to the 1950s and reflect the artistic style of the early 20th century.

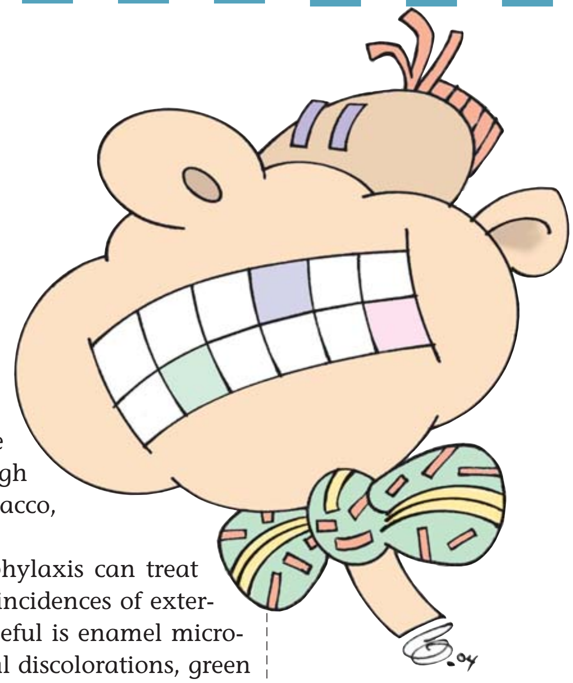
Scott Swank, DDS, curator of the museum said "The temporary exhibit, The Art of Smiles: Posters Around the World, provides an opportunity for the museum to bridge the art world and the dental world by showcasing selected posters from the museum's extensive poster collection and bring to life the history of dental industry advertising. Some of the posters exemplify the dental industry's first attempt at mass marketing. These posters are gorgeous — artistic, bold in color and they mirror the values of the time."

The exhibit also includes a sampling of the museum's stamp collection featuring dental product advertising.

"Sometimes stamp printers included an advertisement on the back of the stamp, so when an individual licked the stamp, they would see an advertisement," Swank said.

The exhibit is free with museum admission and is on display through Jan. 31. For more information, call the Samuel D. Harris National Museum of Dentistry at (410) 706-0600.

Strategies to Determine What's Behind Discoloration



Since dentists frequently are asked for an expert opinion regarding the likely reason for tooth discoloration, it is important to understand the interactions between tooth development and the various agents influencing dentine and enamel formation, wrote authors in the spring 2004 issue of the *Journal of Oral Laser Applications*.

The basic strategy, when faced with the problem of tooth discoloration, is to first identify the cause an applying a treatment based on the philosophy of "as much as required but as little as necessary," said Drs. Jackson Liu, Peter Verheyen, and Laurence Walsh in the article.

When assessing a patient with tooth discoloration, it is important to figure out the nature of the problem, particularly whether the stains are a result of external or internal factors. With internal staining, factors such as pigments of various types have become incorporated into the dentine or enamel, either during its formation or after eruption. With external discoloration, a superficial layer forms on the surface of the tooth through factors including tobacco, coffee or tea use.

Professional prophylaxis can treat the tooth surface in incidences of external staining. Also useful is enamel microabrasion. For internal discolorations, green laser light from an argon laser or KTP can show dramatic results with only one treatment, the authors said.

In determining a final diagnosis of the reasons for dental discoloration, the authors said it is important to take a thorough patient history as well as a medical history during the period of tooth development; residence history, including family history, previous dental treatment, fluoride levels in drinking water; cases of dental trauma, chronology, especially when the discoloration was first noted; oral hygiene habits; and lifestyle habits such as smoking, eating and drinking.

"Go confidently in the direction of your dreams. Live the life you have imagined."

HENRY DAVID THOREAU

Upcoming Meetings 2005

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

2006

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

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

A Case for Absolute Anchorage

FRANK CELENZA, DDS

ABSTRACT

It would be an understatement to say that implant technology has changed the face of dentistry in the past 10 years or so. Both the surgical and restorative specialties have undergone dramatic transformation from treatment planning through all phases of rehabilitation. However, the same cannot necessarily be said for the specialty of orthodontics. Although it could be argued that implants have had an impact on the planning and setup of orthodontic cases (such as in congenitally missing teeth situations), the actual utilization of implants as an integral part of mechanotherapy has only begun to be realized. The ultimate extension of this application of using implants to enhance tooth movement would be to employ implants that are designed solely for the purpose of facilitating orthodontic therapy, with no intention to restore, but rather to explant such implants, after their purpose is fulfilled.[1]

The use of endosseous implants as anchor units has been well studied and documented in the literature. Once osseointegrated, rigid endosseous implants can provide excellent orthodontic and orthopedic anchorage.[2-4] In fact, more recently it has become apparent that implants not only withstand orthodontic loads quite satisfactorily, but they seem to adapt to orthodontic load and demonstrate localized bone densification in response to it.[5]

Predictable and controlled molar distalization has always been a problematic movement to accomplish in orthodontics, because it places great demands on an insecure and imperfect anchor system in the natural dentition. However, achieving successful molar distalization (or "distal driving") would be a desirable outcome in many cases, because it can transform an extraction case into a non-extraction case by regaining lost space and arch length, among other reasons.

In a recent issue of *Orthodontic Seminars*, Cisneros summarized the findings of a pool of experienced orthodontists with regard to their experi-

Author / Frank Celenza, DDS, is certified in both orthodontics and periodontics. He maintains a private practice in Manhattan.

Figure 1. Pretreatment maxillary occlusal. Note crowded nature of dentition and labially locked upper left cuspid with insufficient arch space for correction.

Figure 2. Preparation of the palatal osteotomy is achieved by soft tissue punch and single drill to prepare osteotomy and shoulder.

Figure 3. Lateral cephalogram with implant in place.

ences with molar distalization.[6] Each of these clinicians commented on their experience using the various conventional mechanics with which they are familiar. The overriding finding in that study was that molar distalization is achievable, but is always associated with some degree of untoward side effect. The most common side effect is anterior dental protrusion.

Interestingly, because implants are rigidly attached to their investing bone, they offer to orthodontists the potential to provide what is known as "absolute anchorage." The implication is that predictability of the orthodontic outcome increases dramatically, and furthermore, control of the appliance is placed entirely in the operator's hands thereby eliminating the great variable of patient compliance.

The purpose of this paper is to present a case report which illustrates the use of a single palatal implant for absolute anchorage to achieve distal driving.

Material and Method

A 35-year-old female patient presented with an Angle Class II malocclusion due to maxillary protrusion. Conventional orthodontic therapy commonly would lend the option of upper first bicuspid extraction to regain lost space, particularly on the patient's upper left quadrant, where the cuspid is locked out of arch alignment buccally (**Figure 1**). By using controlled molar distalization mechanics, in an absolute anchorage system afforded by the inclusion of a palatally placed endosseous implant, the upper posterior dentition can be driven posteriorly into a Class I occlusion, and then harnessed to retract the anterior teeth into a proper overbite and overjet relation, obviating the need for extraction.

The patient was already missing upper second molars, which made the treatment somewhat easier, but that is not a requirement. Moreover, since the dentition was already deficient in tooth number, preservation of all remaining teeth became even more critical.

The case was initiated by the surgical placement of a single mid-palatal implant. The Straumann Orthosystem was designed for this purpose and is very simple and expedient to use. A single carpule of local anesthesia is delivered to the palatal mucosa in the region between the bicuspid teeth on both sides of the midline. A mucosal trephine was used to punch out a core of soft tissue at the implant site, completing the entirety of the soft tissue management of the implant placement. This "punch and place" technique eliminates the need for incision, flap and sutures.

A round bur was introduced to the center of this punch to score the palatal bone and initiate the preparation of the hard tissue osteotomy. A spade was used with copious water irrigation to drill the osteotomy to its full 6 mm depth, simultaneously preparing a shoulder for seating of the implant, in one drilling motion (**Figure 2**). A 6 mm long, by 3.3 mm diameter orthosystem implant was carried by hand in its carrier and self tapped into the fresh osteotomy using a ratchet wrench and seated until the underside of the collar was seated in the prepared shoulder and flush with the underside of the palatal bone. Full seating of the implant should be verified by visualizing a lateral cephalogram (**Figure 3**).

Various healing caps and abutments can be placed over the implant, including an occlusal screw to protect the abutment threads and keep the implant as unobtrusive as possible (**Figure 4**).

The implant should be firm and immobile, with primary stability, at placement. The patient must be instructed not to contact or mobilize the implant during the initial healing phase. Orthodontic therapy can commence immediately, if not prior to placement of the implant, for the pur-

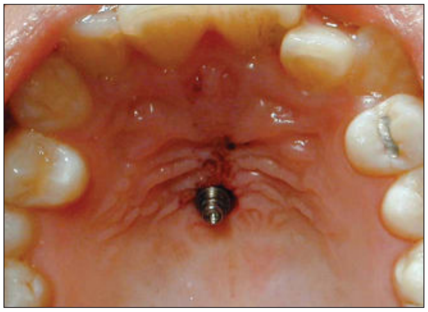


Figure 4. Implant in place with occlusal screw.

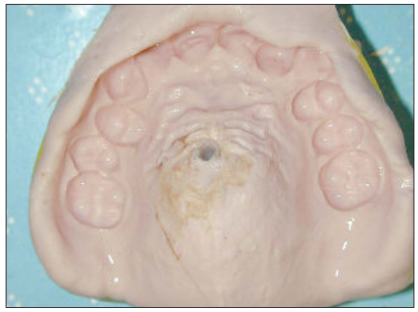


Figure 5. Impression lifts off impression cap and registers implant position.

Figure 6. Transpalatal arch in place, bonded to first bicuspids and soldered to implant abutment, establishing indirect absolute anchor system. Sectional orthodontic appliance is activated by virtue of buccal coil springs.

Figure 7. Molar distalization complete.

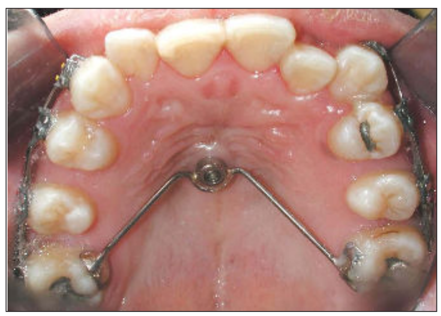


Figure 8. Transpalatal arch is retrieved and reconfigured to secure molars as absolute anchors.

pose of initial leveling and aligning of the dentition and to get the fixed appliance up to working arch wire gauge before actually loading the implant. This was accomplished through buccal sectional appliance placement, from the first biscpsids through the first molars. This has the added advantage of eliminating the need to place appliances on the anterior teeth during the actual distal driving phase of treatment.

After eight weeks of integration, an alginate impression can be made to register the implant location. This can be accomplished by placing a plastic impression cap onto the head of the implant, packing alginate around it, and lifting it off with a conventional alginate impression tray (**Figure 5**). It is not necessary to impress the entire dentition, or even the buccal surfaces of the teeth, however; it should be pointed out that this process is greatly simplified if the operator uses a bonded rather than a banded appliance, as is illustrated presently.

Once the impression is obtained, a lab analog is placed in the index, and the laboratory model is poured and sent to the lab where a stainless steel transpalatal bar is fabricated to be bonded to the palatal surfaces of the maxillary first bicuspid teeth and soldered to the stainless steel abutment that will be placed upon the implant.

After 10 weeks from implantation, the implant can be loaded. This is accomplished by acid etching and sealing the palatal surfaces of the maxillary premolars, using conventional orthodontic bonding materials. The transpalatal arch was positioned by placing the abutment to which was soldered over the implant and securing it with the occlusal screw. Light cured resin was flowed into the areas to be bonded and cured. The absolute anchor system is now intact (**Figure 6**).

The orthodontic appliance is then activated by compressing open coil springs on a .020-inch stainless steel sectional archwire bilaterally from first bicuspid to molar tube. The force application is sent entirely to the molar teeth by virtue of the immobile indirectly anchored first bicuspids.

At subsequent visits, the appliance is checked for bond failure of the transpalatal arch and repaired immediately and easily, if necessary. Continuous activation of the appliance is ensured by placing longer coil springs as the arch expands distally. The second bicuspid teeth are noted to also drift distally despite not being loaded directly, and this is presumed to occur through tension in the transeptal fiber system as the molar teeth move.

When the upper first molars have been distalized to the point of acceptable relation (Class I or super-Class I), the transpalatal arch can be refabricated to allow retraction of the anterior teeth (**Figure 7**). This is accomplished by replacing the open coil springs with closed coils to maintain the space created between first bicuspid and molar

Figure 9. Completion of orthodontic treatment.

Figure 10. Post-treatment panorex.

during lab fabrication. The transpalatal arch is debonded from the bicuspids, and unscrewed from the head of the implant. A new impression is taken just as before, and now a transpalatal arch to be bonded to the palatal surfaces of the (relocated) molars and soldered again to the implant abutment is fabricated. This new transpalatal arch is then secured just as before but now to the molar teeth establishing another absolute anchor system to be used to retract the anterior teeth (**Figure 8**).

The orthodontic appliance should be completed by this stage so that all teeth are engaged in a full archwire, which is then used to guide the teeth into alignment by using chain elastics or stretched coil springs attached to the molar teeth thereby effecting retraction (**Figures 9 and 10**). When proper arch form is achieved with acceptable occlusion, the anchor system can be dismantled as before, and a suitable orthodontic retainer is fabricated, followed by debonding of the appliance and explantation of the implant.

Implant explantation is achieved by debonding the transpalatal arch, and unscrewing the abutment from the implant. Under local anesthesia again, an explantation guide sleeve is introduced by screwing it into the implant. The explantation trephine is used to core the implant out of the palate taking care to visualize the depth markings on its surface and coring down about two-thirds the length of the implant. Integration is then broken by reverse torquing the implant out using the implant carrier and wrench. A small socket is left by the removal of the implant, which requires no special dressing or closure. Healing is usually uneventful and the wound is barely evident after two to three weeks.

Discussion

A relatively simple means to achieve dramatic molar distalization has been presented and illustrated by employing an indirect absolute implant anchor system. One obvious advantage of this modality is that it obviated the need for further tooth extraction for the purpose of achieving orthodontic alignment. However, numerous other advantages of this system were realized by using it. First, the appliance mechanotherapy was greatly simplified. No intricate archwire bending or forming is necessary to hold teeth in place as would be needed if the dentition were the sole source of anchorage. The appliance as outlined is quite streamlined and comfortable. Moreover, no activation or intervention of any auxiliary or extraoral devices (such as a headgear) by the patient is relied upon, thereby eliminating the dependency on patient compliance. Further, the expediency of treatment is greatly facilitated by this anchor system, not because excess force can be applied to the teeth, but because teeth can be activated and mobilized as a block. This is afforded by the strong anchor system which does not run the risk of being overpowered by the active segment and so preservation of the anchor system is not critical.

Conclusion

A simple and practical means to achieve molar distalization has been presented, which for the first time, incurs no untoward side effects and is achieved with great predictability and operator control. CDA

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Evidence-Based Approach for Treatment Planning Options for the Extensively Damaged Dentition

GEORGE C. CHO, DDS

ABSTRACT

Restoring the extensively damaged dentition has always been a difficult decision-making process for the dental practitioner. Decisions to restore these teeth were primarily based on the fact that "fixed" teeth are typically better functionally than "removable" teeth and better esthetically than "no" teeth. Prior to dental implants, restoring missing teeth and extensively damaged teeth utilizing traditional therapy such as crown lengthening, root hemisection/amputation, endodontic therapy, apical surgery, post and cores and splinting were the options available to our patients. These teeth typically required the expertise of additional specialist, however their prognosis and success rates were typically guarded at best. Presently, dental implant success rates have been clearly identified and documented in the literature which now questions the survivability and success rates of the traditional mode of therapy for extensively damaged teeth. This paper will attempt to review the dental literature for various traditional modes of therapy for restoring the extensively damaged to provide a consensus of their survivability to help the practitioner to present options and prognosis for their patients.

Technological advancement in dentistry has allowed the practitioner to re-evaluate traditional modes of dental therapy for the extensively damaged dentition. These advancements in dentistry have given us better options to restore the dentition without compromising the remaining teeth and periodontium. Devan stated that "our aim must not merely be the meticulous restoration of that which is missing but the perpetual preservation of that which remains." This statement has had various interpretations during the evolutionary process of dentistry and is dictated with materials and technology available at that period of time.

Extensively damaged teeth or periodontium would typically require multiple dental procedures that physically weakened the teeth or decreased the periodontal support for survivability of the remaining teeth, but did provide for tooth restoration and replacement

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Figure 1a. Radiographs reveal localized vertical bone loss on distal root on No. 19 with missing teeth Nos. 22, 23, and 24.

Figure 1b. Restoration of root amputation of No. 19 with rigid connection between Nos. 18 and 19 and nonrigid connection to FPD Nos. 20-27.

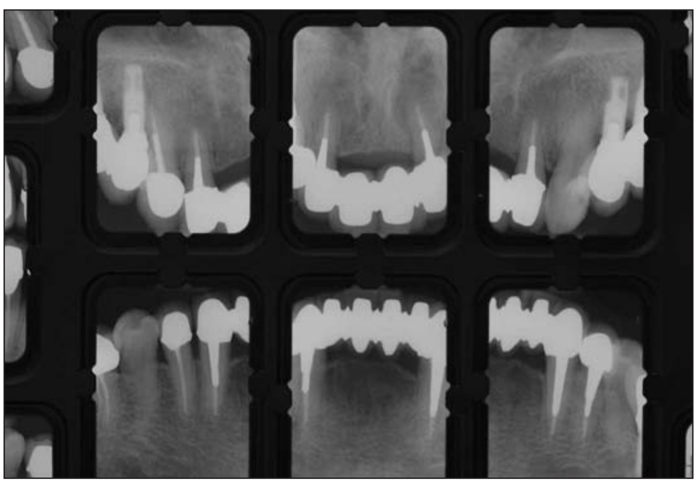

Figure 2. Endodontically treated abutment teeth supporting multiple-unit fixed partial dentures.

Figure 3a. Radiograph reveals poor prognosis for teeth Nos. 13 and 15 with guarded prognosis on tooth No. 14.

Figure 3b. Distal root amputation and root canal therapy on tooth No. 14 utilized as a distal abutment for a four-unit fixed partial denture on Nos. 11-14 with nonrigid attachment connection to splinted fixed restorations on teeth Nos. 7-10.

(**Figure 1a**). Such examples include, full coverage esthetic crown restorations, endodontic therapy with post and cores, root amputation/hemisection, and osseous surgical periodontal therapy (**Figure 1b**). These accepted traditional modes of therapy were utilized to restore extensively damaged or missing teeth however their survivability or success rates have now come to issue because of improved alternatives to treatment.

The advancement of dental implants has made an impact on treatment planning for missing and extensively damaged teeth, however many practitioners were hesitant (as they should be) to provide this new type of treatment since they were reasonably confident and comfortable that the traditional methods of replacement and restoration could provide some years of service. Langer and Sullivan have stated that “traditional clinicians would initially reserve the use of implants for the category of desperations and were recommended as a last resort, intended for patients disabled by previous dental experiences or unable to wear conventional removable appliances.”[1] As implant success rates reported 85 percent to 95 percent, and implant education became more readily available, conventional treatment planning techniques are less likely to attempt some of the older heroic and less predictable technique.

It is generally accepted that patients prefer teeth than to being edentulous. Given this statement, the clinician’s option for restoration for the missing or extensively damaged dentition required crowns, fixed partial dentures or removable partial dentures (**Figure 2**). Crowns and fixed partial dentures were considered state of the art for tooth replacement and restoration, which is significantly better than the

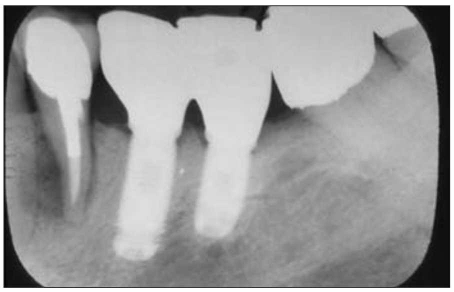

Figure 4. Root fracture of endodontically treated tooth No. 21 that was previously an anterior abutment for a four-unit fixed partial denture. Implants were placed in Nos. 19 and 20 when there were no radiographic lesions for tooth No. 21.

Figure 5a. 1990 periapical radiograph with apparent intact periodontium.

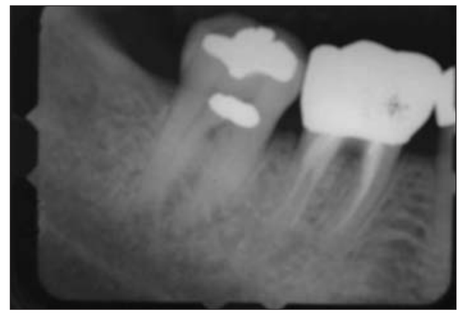

Figure 5b. 1994 periapical radiograph with radiographic furcation lesion.

Figure 5c. 1999 periapical radiograph with significant radiographic furcation lesion. Tooth No. 31 crown restoration was done in 1997 due to a possible cracked tooth causing the bone loss as surmised by the periodontist.

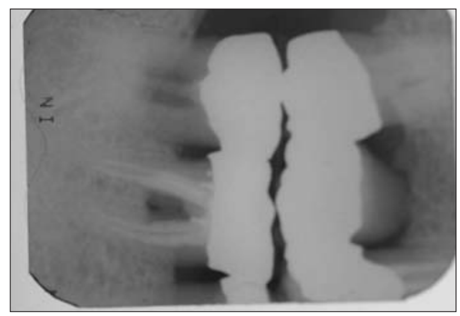

Figure 5d. 2002 bitewing radiograph with minimal changes compared to 1999. Patient has excellent oral hygiene since 1990 and has periodontal hygiene maintenance every three months.

alternative of removable partial dentures, complete dentures, and to no teeth at all. Therefore, the clinician typically planned other adjunctive procedures such as root canal therapy, post and cores, osseous reduction and hemisections or amputations in order to support splinted crowns and fixed partial dentures as the alternative (removable prostheses) was always considered less acceptable when it came to function, sometimes esthetics and socially (**Figures 3a-b**). The "heroic" type of adjunctive procedures gave the ability to place restorations but the longevity was always questionable however, it was considered the best treatment available. With the long-term success rates of implants, we must now re-evaluate the success rates of traditional modes of therapy and evaluate their long-term success.

Restoration of Endodontically Treated Teeth

Endodontically treated teeth contain approximately less than 9 percent moisture content than nonendodontically treated teeth.[2] It is postulated that due to the decrease in moisture content, the teeth are inherently more brittle and therefore can be more susceptible to fracture. A study by Carter et al. has indicated that dentin from endodontically treated teeth exhibits significantly lower shear strength and toughness than dentin from vital teeth.[3] Several authors have stated root canal therapy success rates can range as high as 70 percent to 95 percent or as low as 64 percent to 75 percent, depending upon training and experience.[4,5]

Goodacre and Spolnik reviewed literature for prosthodontic management of endodontically treated teeth and found the incidence of endodontic treatment required after tooth preparation has ranged from 3 percent to 23 percent and fixed partial dentures with complex prostheses had higher incidence rates than single crowns.[6] The incidence is higher when the prepared teeth have deep carious lesions and when periodontal disease has resulted in considerable bone loss which is characteristic for extensively damaged teeth.[6] Other studies have evaluated endodontically treated teeth for FPD or RPD abutments and found that these teeth had a greater failure rate than nonsurgical root canal therapy for single crown restorations.[7] Reasons for endodontic failures can be due to microleakage after post space preparation, microleakage after post cementation, leakage during provisional restorations and leakage with the permanent restorations.[8] Turner has reported 100

Table 1

Conservative Surgical and Nonsurgical Therapy, Molars With Furcation Involvement (Carnevale et al.)

Author	Years	No. of teeth	% Success	% Teeth lost
Hirschfield, et al., 1978	15-53	1464	69	31
Ross and Thompson, 1978	5-24	38	88	12
Wood, et al., 1989	10-34	164	77	23
Goldman, 1986	15-34	636	56	44
McFall, 1982	15-29	164	43	57
Wang, et al., 1994	8	87	70	30

Table 2

Root Resection Therapy in Molars With Furcation Involvement (Carnevale, et al.)

Author	Years	No. of Teeth	Success %	Failure %
Bergenholtz, 1972	2-10	45	*	6
Klavan, 1975	3	34	97	3
Langer, et al., 1981	10	100	*	38
Erpenstein, 1983	4-7	34	80	20
Buhler, 1988	10	28	*	32
Carnevale, et al., 1991	10	488	94	6

*Author unable to calculate percent success rate with given data

Figure 6a. Tooth No. 3 with mesial buccal root amputation and root canal therapy. Prefabricated post was placed and composite build-up, portion of the composite build-up fractured prior to final impression appointment.

Figure 6b. Gingival view of restorations for tooth No. 3. Mesial buccal pontic form was designed to help guide proxy brush into the mesial area of the palatal and distal root as well as distal to tooth No. 4.

failures of post retained crowns and stated that post loosening was the most common type of failure.[9] Sorenson and Martinoff's retrospective study on 1,273 endodontically treated teeth found 36 post and cores failed out of 420, which was due to post and core dislodgement and tooth fractures[10] (**Figure 4**). It can be summarized that the greater amount of tooth structure remaining after root canal treatment can increase the longevity of that restoration.

Restoration of Periodontally Involved Teeth

Traditional periodontal therapy involves resolution of the inflammatory process of the periodontium. This typically involves elimination of soft and hard deposits from the surfaces of the tooth via scaling and root planning and sometimes combined with periodontal surgery involving pocket reduction (soft or hard tissues), tunnel preparations and or root hemisection/amputation.[11] Many of these procedures will improve the local environment by eliminating the causative microorganism but the price one pays is decreased tooth support or tooth strength. Björn et al. reported that if periodontal defects go untreated, signs of bone loss in the furcation area can increase from 18 percent to 32 percent over a 13-year period[12] (**Figures 5a-d**).

Surgical and Nonsurgical Therapy, Molars With Furcation Involvement

There is a wide range of success rates and years of study reported for surgical and nonsurgical therapy involving molars with furcation involvement ranging as low as 56 percent to as high as 88 percent[11] (**Table 1**). The Ross et al. study evaluated 387 maxillary molars over a five- to 24-year period and found

Figure 7a. Fifteen-year-old six-unit anterior fixed partial denture with missing teeth Nos. 7, 8, 9, and 10 with abutments on Nos. 6 and 11. Tooth No. 6 abutment was previously endodontically treated and is currently loose.

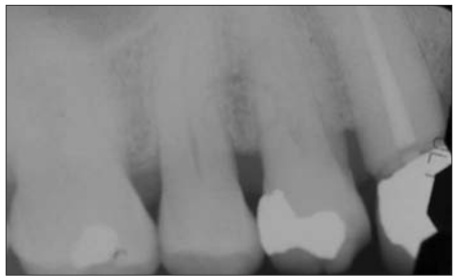

Figure 7b. Preoperative periapical radiograph of tooth No. 6 reveals the fact that tooth No. 6 abutment is loose. Upon removal of the restoration, the coronal structure of tooth No. 6 was fractured.

tooth mortality was 12 percent with furcation defects treated via nonsurgical and surgical means.[13] Goldman et al. found after a 15- to 34-year period of maintenance and conservative treatment of 636 furcation involved, 44 percent of the teeth were lost.[14] Hirschfield et al. and McFall's studies reported results similar results where the multi-rooted teeth with furcation involvement had a higher percentage of tooth mortality compared to that of single rooted teeth.[15,16]

Root Resection

Root resection/hemisection techniques were reserved for multi-rooted teeth that had furcation involvement due to moderate to severe bone loss. These teeth would require root canal therapy, osseous surgery and post placement in order to restore with crown restorations (**Figures 6a-b**). **Table 2** shows numerous authors on the treatment of root resection therapy in molars with furcation involvement with their percent failure which ranged from 3 percent (Klavan) to as much as 38 percent (Langer et al.).[11] Longer periods of evaluations typically revealed higher percentage of failure such as Langer's and Erpenstein's study.[17] Langer et al. involved a 10-year retrospective study and reported 38 percent failure, where 16 percent of the teeth were lost in the first five years and the remaining 84 percent were lost between five and 10 years.[18] The dental literature has reported variable success rates among authors. Variability in the reported results has been rationalized that periodontal procedures are very technique sensitive, oral hygiene must be excellent and the restoration must be performed with correct restorative expertise.[19] Typical failures associated with root resection involve root fracture, caries, periodontal problems, abutment and root fractures (**Table 2**).[11]

Long-Term Fixed Partial Dentures

Dental literature has had divergent results for documenting successes or failures with fixed partial dentures. The reason is the difficulty in performing randomized clinical trials with dental patients, non-standardized methodology and trial conduct, varying periods of follow-up evaluation and nonstandard definition of failure. Due to these differences, it is very difficult to assess the overall effectiveness of fixed partial denture therapy. Many of the studies were performed without control groups and therefore, are prone to bias and may show generally too-positive effects of treatment. However, systematic reviews including nonrandomized clinical trials can provide some evidence for prognosis.[20] Scurria et al. have identified eight studies since 1960 and were able to utilize a meta-analysis of fixed partial denture survival. "When failure was defined as removal 92 percent and 75 percent of the FPD's were estimated to survive at 10 and 15 years, when a broader definition of failure was used, namely, combining FPD's removed with those that technically failed and needed replacement, 87 percent and 69 percent were estimated to survive at 10 and 15 years. Abutment survival at 10 years was estimated to be 96 percent."[21]

The hypothesized contributing factor for the various divergent data presented in the literature could be due to the increased mean age of the patient population requiring these dental procedures. Older population of patients may be on medications which may have side effects of depressed salivary function and possible decreased motor coordination leading to worse oral hygiene. Nonuniform definition of failure as well as varying operator skill has also been reported to be contributing factors for the range of data presented.[22]

Failures associated with traditional therapy can be classified as biologic failures and mechanical failures. Biologic failures are caries, coronoradicular fracture, root fracture periodontal disease and apical lesions. Mechanical failures involved loss of retention with the retainer and or post and cores, porcelain fracture and metal fracture[23] (**Figures 7a-b**). One of the problems with defining failure is which mode of failure occurred first? Did the retainer or post become loose and then caries followed? Or did the caries occur first and then cause the loosening

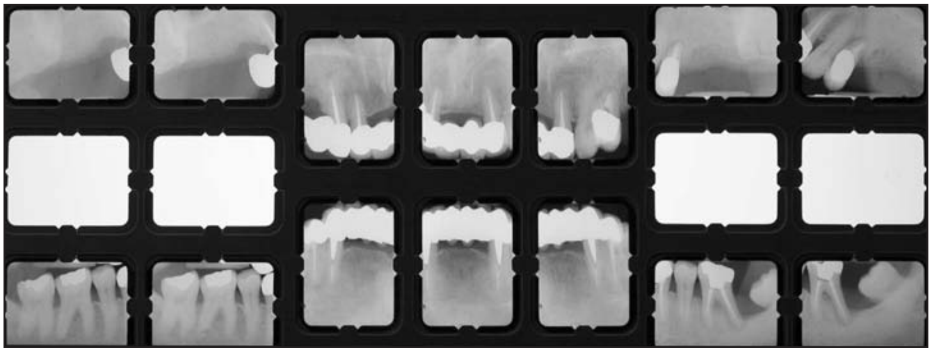

Figure 8a. Preoperative periapical radiograph exhibiting multiple missing teeth, multiple root canal therapy with posts, multiple fixed partial dentures with a distal cantilever on No. 5, extruded molars on teeth Nos. 30 and 31, endodontically treated tooth No. 12 with periapical radiolucency, endodontically treated tooth No. 19 with localized vertical defect on the distal with radiographic furcation involvement and severely mesially tilted third molar tooth No. 17.

Figure 8b. Right-side view of the patients preoperative restorations. Note that tooth No. 29 does not have any restorations.

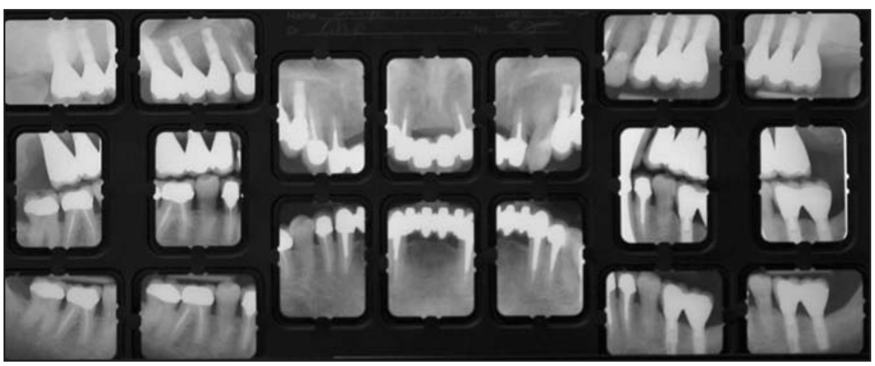

Figure 8c. Periapical radiographs of completed treatment. Nos. 12 and 17 were extracted, some post and cores were replaced and implants were placed the edentulous areas.

Figure 8d. Right-side view of the patients completed restorations. Note that tooth No. 29 was maintained without restorations.

of the retainer or fracture of the post or tooth? Regardless which occurred first, the fact remains that extensively damaged teeth have been traditionally utilized to support and retain restorations under difficult circumstances involving compromised support and minimal remaining tooth structure.

Hammerle et al. studied long-term analysis of biologic and technical aspects of FPD and cantilevers and show a close correlation between loss of retention and carious lesions. Ten percent lost vitality, 1 percent showed periapical pathology, 8 percent developed secondary decay, 8 percent lost retention, material fracture occurred 1 percent to 3 percent of the abutment teeth, and fracture of abutment teeth amounted to 3 percent and was twice as frequent at abutments adjacent to cantilevers compared to abutments not adjacent to cantilevers.[24] These problems may be at least partially avoided by performing optimal plaque control and by strictly observing the rules for preparation of retentive FPD abutments.[24] Similarly, Randow et al. evaluated technical failures and complications for extensive fixed prosthodontics and reported a positive correlation between the number of failures and cantilevers.[25] Glantz et al. assessed the quality of fixed prosthodontics and found a cumulative success rate of 68 percent over a 15-year period.[26] It appears the common destructive element in the extensively damaged has been biomechanical failure of the prosthesis and its underlying root structure and by the nature of the problem, the solution for extensively damaged teeth has been limited at best.[27]

Implants

The advantages of dental implants are the replacement of missing teeth without the necessity of altering adja-

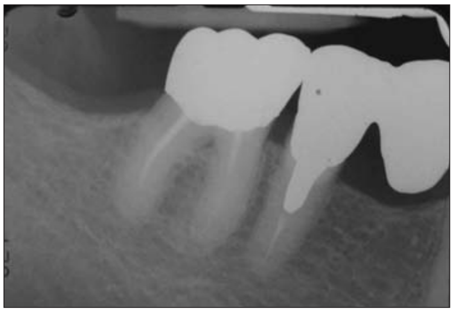

Figure 9a. Preoperative periapical radiograph revealing inadequate root canal therapy on tooth No. 30, root canal therapy on tooth No. 29 with large post and is distal abutment for three- unit fixed partial denture and the anterior abutment also is endodontically treated with a post and core.

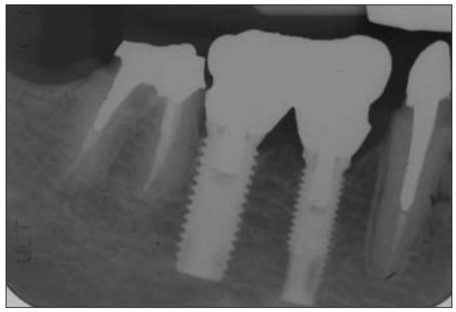

Figure 9b. Periapical radiograph revealing that tooth No. 29 was removed and implant were placed in tooth No. 29 and No. 28 position while teeth No. 27 and No. 30 were endodontically retreated with placement of new post and cores.

Figure 9c. Right-side view exhibiting the crown restorations on teeth and implants opposing an implant supported and retained maxillary overdenture.

cent healthy or extensively damaged teeth, providing occlusal support and function similar to natural teeth and esthetics. The disadvantages of dental implants are increased cost, increased treatment time and surgical procedure. The survival rates for implants have been well documented in the dental literature and should be presented for an option for missing teeth as well as replacement for extensively damaged teeth.

Brånemark and Adell initially reported implant success rates for edentulous jaws of 91 percent for the mandible and 81 percent for the maxilla in the late 1970s and early 1980s.[28,29] In the early 1990s, Henry et al. reported similar success rates for implants placed in partially edentulous jaws as those found by Brånemark and Adell.[30] Other studies by Brånemark and Albrektsson suggest implant cumulative survival rates ranging from 95 percent to 99 percent for the mandible and 85 percent to 90 percent for the maxilla for edentulous jaws.[31,32] More recent studies utilizing meta-analysis of implants in partially edentulous jaws report survival rates of 94 percent for implant fixed partial dentures and 98 percent for single crown restorations after a six- to seven-year period.[33] Implant survival rates utilizing standard life table principles has reported similar success rates for maxilla and mandible and reported survival rates of 95.6 percent for implant supporting tooth prostheses and 96.1 percent for cantilever fixed partial prostheses.[34]

The plethora of implant survival rates reported in the dental literature show favorable cumulative survival rates ranging from the low to high 90s and therefore should be a viable treatment plan option for any missing and extensively damaged teeth.

Conclusion

It appears implants can solve many of the shortcomings of traditional therapy. Implants are resistant to decay, mechanically stronger than teeth that are endodontically treated and have had post and cores and do not utilize adjacent teeth for any support or retention to restore missing teeth, and appears to have higher survival rates (**Figures 8a-d**). Extensively damaged teeth typically would require endodontic, periodontic and restorative therapy, and through the present literature, we can inform patients that survivability over the next 10 to 15 years can range from 69 percent to 87 percent as compared to implants which can have an excess of 90 percent to 95 percent survival rate. Restoration of extensively damaged teeth typically have a guarded to poor prognosis because teeth are many times used as abutments for fixed partial dentures or removable partial dentures. These teeth have to support greater numbers of restorations (fixed partial dentures) with less periodontal and structural support. But if implants can be used in conjunction with the extensively damaged teeth, these teeth may have improved prognosis given the fact of additional support by implants (**Figures 9a-c**).

Under ideal conditions, we may approach the 87 percent success rates for restorations, but on the average somewhere between 69 percent and 87 percent may be more reasonable for long-term survivability for restorations. Utilizing the presented success rates for traditional therapy on extensively damaged teeth, it appears that additional treatment and cost may need to be performed within the first 10 to 15 years of service.

The cost of any dental treatment varies widely within North America but implant treatment can range from 1 to 1½ times that of conventional multi-specialty dental therapy. Given the higher percentages for implant survivability, it may not be cost and time effective to attempt multiple specialty procedures on teeth with guarded to poor prognosis. As Langer et al. stated "we had now entered a new arena of treatment (implants) previously unknown to modern dentistry and therefore would now use it out of strength rather than in a state of desperation." CDA

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Surgical and Prosthetic Concepts for Predictable Immediate Loading of Oral Implants

GEORGE E. ROMANOS, DDS, DMD, PHD

ABSTRACT

Immediate loading of oral implants is an established concept for lower jaw restoration using four intraforaminal implants splinted together with a bar. There is a lot of misunderstanding in the literature and not exact definition of the term "immediate loading." Moreover, the number of implants to restore edentulous jaws is relatively high to compensate for the loading forces and dependent on the bone quality and quantity. This report presents the different surgical and prosthetic concepts for immediate loading to get long-term success in the upper and lower jaw. When the primary stability is adequate, only six implants may be loaded immediately after surgery, if the implants are splinted using a provisional fixed restoration. Using a number of six primary stable implants, it is possible to restore edentulous jaws independent on the clinical situation. This concept may be used successfully in the posterior part of the mandible when three implants are splinted with provisional crowns and loaded immediately. The biomechanical aspects, the implant design and surface seem to be of great importance for the long-term success in compromised and advanced surgical cases. In conclusion, immediate loading of oral implants may be successful if a primary stability as well as immobilization (splinting) immediately after surgery are taken care.

A loading free period of three months in the mandible and six months in the maxilla is a conditio sine qua non according to the traditional Brånemark concept presented in 1983.[1] Excessive micromotions larger than 100 µm during this healing period can have a negative effect on the osseous integration of oral implants because fibrous tissue may form at the bone-implant interface disturbing the remodelling processes, which leads to implant mobility.[2-4] A short healing period following implant placement, as well as immediate loading of implants can have very positive social and psychological effects for the patient.[5]

A direct immobilization of the inserted implants using a curved U-shaped bar showed cumulative success

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Acknowledgement / The author would like to thank especially Dr. G.H. Nentwig, professor, for his critical suggestions in the treatment plan. Special thanks to R. Arnold, CDT, Frankfurt, for his dental technical support in the whole project of immediate loading.

rates of more than 88 percent.[6-7] Furthermore, indirect immobilization using telescopic prefabricated abutments connected with a full denture immediately after surgery (for the first 10 days of healing) has been reported with success rates of about 97 percent.[8]

Fixed implant-supported reconstructions may load implants immediately after surgery without implant failures if certain requirements are met. Some authors recommended a high number of implants with a length higher than 10 mm as well as a rigid provisional splinting, and that cantilevers should be avoided especially in the provisional prosthesis. In addition, excellent implant stabilization should be attained, and sufficient bone quantity as well as quality should be available.[5, 9-11]

There are many open questions today concerning the treatment protocol of immediate loading:

- What does "immediate loading" mean?
- How many implants are mandatory in each edentulous jaw in order to get osseointegration, when implants are loaded immediately after surgery?
- Is immediate loading possible in cases with bone augmentation in resorbed alveolar ridges?
- Are there any high risks, such as contraindications for immediate loading?
- The present report will try to answer these questions based on the recent literature and the presentation of different clinical case reports.

What Is "Immediate Loading"?

There is no general agreement in the literature about the term "immediate loading." There is no doubt that "immediate" should be better clarified and "loading" should be defined for the purpose of facilitating the critical analysis of the data published by different authors in the recent literature. Some papers refer to an installation of the implant-supported overdenture in the first three to four days of healing some others recommended loading 10 days after surgery using bicortical fixation of six Brånemark implants in the symphysis and present high success rates after six months of loading.[6-7,12-13] The author considers that the term "early loading" should be used in the later case, because the implants were loaded 10 days after their insertion and this should not be considered as "immediate." The main reason for the use of the immediate loading concept is to significantly reduce the total treatment period, which has positive social and psychological effects for the patient and increase significantly the patient comfort avoiding the use for a long time a removable prosthesis.[5]

There is no general agreement in the literature about the term "immediate loading."

Immediate loading of single tooth implants has been demonstrated using provisional crowns without any or with minimal occlusal contacts.[14-16] In order to use the term "immediate loading" in such cases, the implants should have occlusal contacts in the centric in the first days of healing. In cases of immediate restorations, i.e. in the single tooth implants or small implant-supported restorations without occlusal contacts, which will be replaced later with the final restorations in a physiologic occlusion, the term of "immediate supply" (or temporalization) and not "loading" should be used. Only the study published by Glauser, et al. reported full contacts of the immediately loaded single tooth Brånemark implants in centric occlusion and showed cumulative success rates of 82.7 percent after one year of loading.[17]

In partially edentulous free-end clinical cases there are not sufficient data showing the prognosis of immediately loaded implants. Definitely, there is a biomechanical risk in the free-end restorations because of the applied bending moments around the implants especially when these implants are immediately loaded. Some authors suggest early loading (two to six weeks after surgery) in the posterior mandible using implants with rough, sandblasted, large grid acid-etched surfaces.[18] One year after loading the implant survival was 100 percent. The authors recommend careful selection the patients, as well as the implant sites in order to use the early loading concept successfully. In contrast to these findings, the authors were able to evaluate immediately loaded implants with a progressive thread design in 12 patients. In a recent prospective well-controlled randomized clinical study, the immediate loading concept was compared with delayed loaded implants (split-mouth) in the posterior part of the mandible. The clinical and radiological examination after two years of loading did not present any statistically significant difference in the two study groups (immediate vs. delayed).[19]

In fully edentulous cases there are few studies showing the long-term prognosis of immediately loaded implants. Different authors immediately loaded non-submerged implants using a provisional restoration and connected them later with submerged healed implants. In their evaluation, the authors reported increased success rates for this immediate loading concept. They also connected such implants together with completely healed (osseointegrated) implants to better compensate the loading forces.[20] The implant primary stability is extremely important and the occlusal scheme should have symmetrical contacts keeping the vertical dimension immediately after installation of the provisional bridges.[6,11,21] Lateral eccentric contacts should be eliminated in the provisional prosthesis and the patient should use a soft diet for the first four to six weeks of healing.[22]

Implant Number for Immediate Loading to Restore Edentulous Jaws

Recent literature suggests a minimum of four implants when they are immediately loaded using a removable prosthesis. This number is higher when a fixed reconstruction will be fabricated. At least six to eight implants in the upper jaw and a minimum number of five to six implants in the lower jaw has been previously recommended because of the different bone quality in the different anatomic regions.[11,22] The implant design seems to be of great importance in association with the implant length and may influence primary stability. Furthermore, rough surfaces (TPS-coated, SLA, acid etched, acid etched-sandblasted or HA-coated) increase the microgrooves and the cell attachment, and positively affect the implant integration.[23-27] The removal torque was higher on implants with rough surfaces compared to those with smooth surfaces in miniature pigs.[27] Therefore, rough surfaces were considered to be more suitable than machined surfaces and have been recommended for early or immediate loading.[21] Implants with machined surfaces are not recommended for immediate loading especially in the maxilla or in areas with poor bone quality.[21]

Rough surfaces were considered to be more suitable than machined surfaces and have been recommended for early or immediate loading.[21]

Using a new concept of treatment in Sweden, it was possible to place three transmucosal Brånemark-implants in the anterior part of the lower jaw and to load them immediately using a fixed bridge. This “Same-day-teeth”-protocol may not be suited for use in a private practice however, because of the highly precise surgical procedure. According to the first publication based on the Brånemark-Novum-concept, the success rate after one year of loading was 98 percent.[28]

A recent series of clinical cases have documented that indirect immobilization of four primary stable Ankylos implants (placed in the anterior region of the mandible) can be immediately loaded successfully using an implant-supported overdenture. According to this treatment protocol the implants were not splinted together with a bar, but were connected with prefabricated conical abutments (SynCone). These prefabricated abutments have a very precise fit with the secondary copings, which are inserted into the overdenture. The denture should not be removed for a period of 10 days and the patient should be placed on a soft diet program. This treatment protocol has been used in a total of 204 implants in a mean observation period of two years and presented a cumulative survival rate of 97.54 percent.[8] The SynCone-prefabricated abutments have many benefits. They significantly reduce the costs associated with the fabrication of customized castings and allow for better oral hygiene performance in comparison to the bar-retained dentures.

A similar concept but using early functional loading (the implants were functionally loaded within five days after surgery) was recently published using the Brånemark implant system. After two years of loading a cumulative survival rate of 96.3 percent has been observed.[29]

Edentulous upper and lower jaws have been restored with only six Ankylos implants (in each jaw) and immediately loaded implants after implant placement surgery using temporary resin restorations (immediate functional/occlusal loading). The final restorations were placed and cemented provisionally approximately six weeks after placement surgery. No bone loss was presented two years after loading using this concept. The complete treatment protocol has been recently published in a clinical case report.[30]

The present results document a high success rate (97.72 percent) in 15 patients with 132 implants (78 placed in the maxilla and 54 in the mandible) after a loading period of 22.37(±12.62) months. The two implants, which failed before healing and were removed, were maxillary implants placed in a patient with bruxism. All implants exhibited healthy peri-implant soft and hard tissue in contact with the implants (data not shown).

In cases of large peri-implant dehiscences and fenestrations after implant insertion, where a coverage of an exposed implant by bone grafting or guided bone regeneration may be indicated, a traditional healing protocol with a delayed loading concept has been recommended.[7] In contrast to these suggestions, Glauser et al. reported a better prognosis of immediately loaded implants in comparison to the traditional protocol when GBR-technique was performed, because the implants in the augmented regions would be expected to be in contact with the cortical bony plates and not with trabecular bone, presenting a higher stability.[17] There is no data at the moment showing if the augmented areas will be stable over time or if implant exposure may be observed.

Histological Observations of Immediately Loaded Implants

Animal studies have demonstrated that successful osseointegration of implants with a progressive thread design can occur when implants were placed and loaded immediately if some specific conditions are present. Comparison of the histological and histomorphometrical findings of the peri-implant hard and soft tissues on immediately loaded implants and for delayed loaded implants did not show any statistically significant differences in specimens from *M. fascicularis* monkeys.[31-33] The mineralized bone at the interface of immediately loaded implants appeared to exhibit higher density when compared to the bone tissue around the delayed-loaded implants.[32] Higher bone density has been demonstrated at the interface around both immediately- or delayed-loaded implants when compared with unloaded implants in monkeys.[34] This explains that loading in general, seems to promote the formation of dense bone as has been shown elsewhere.[35]

The histological findings involving implants that were placed in humans and immediately loaded showed no fibrous tissue formation (encapsulation). The bone-to-implant contact (osseointegration) was found to be excellent between the immediately loaded implants and the surrounding alveolar bone. These implants had blade or screw thread designs, which were removed because of implant fractures.[36-38] Similar findings were recorded after a histological examination of en bloc human biopsy specimen from a patient who died because of a bronchial carcinoma. A total of 12 Ankylos implants (six in the maxilla and six in the mandible) were examined and the authors were able to observe an implant-bone integration without epithelial proliferation and pocket formation. The histomorphometrical evaluation of bone-to-implant contact within the threads demonstrated a mean of about 51 percent and a mean bone volume of about 52 percent with a tendency toward higher percentages around the implants in the upper jaw seven months after loading.[39] The implants had a progressive thread geometry and sandblasted surface.

Histological specimens obtained in a clinical study conducted by Rocci, et al. with oxidized implants TiUnite (surface) that were subjected to either early or immediate loading and followed for a period of five to nine months showed normal healing around all of the implants.[40] In this study, the implants for only one patient were subjected to immediate functional loading the same day of surgery. The implants in four other patients involved early loading (two months after surgery the implants had occlusal contacts). The investigators performed additional studies to determine the success rate of machined and TiUnite (surfaced) implants. Of the implants placed and followed in this study, 14.4 percent of the implants with machined surfaces failed compared with 4.7 percent failures for the oxidized implants in the first year of loading. The higher failures for the machined surface implants occurred more frequently in smokers and poor (Type IV) bone qualities.[41]

Figure 1a. Bilateral edentulous free-end in the mandible.

Immediate Implants and Immediate Loading

The possibility of restoring upper and lower jaws using implants that are placed immediately following extraction of periodontally involved natural teeth and subjecting them to immediate functional loading represents a very interesting treatment concept

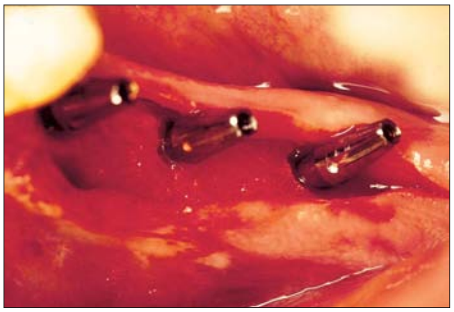


Figure 1b. Placement of three Ankylos implants in the posterior part of the lower jaw for immediate loading.

Figure 1c. Installation of the provisional splinted crowns presenting occlusal contacts.

Figure 1d. Occlusal aspect of the provisional restorations immediately after surgery of the test and control side.

with a lot of possibilities in the future. This treatment protocol may be indicated especially in patients, who may not be able to tolerate a full denture.[30] The excellent primary stability of implants with rough surfaces as well as screwed tapered design provides excellent anchorage in the alveolar socket immediately after tooth extraction.

Results have been reported on immediate loaded single tooth implants placed in fresh extraction sockets compared to immediately loaded implants placed in completely healed bony sites. The survival rates were only 82.4 percent and 100 percent for immediate vs. nonimmediate implants, respectively. In an additional pilot study, Ericsson, et al. were able to follow up 14 immediately loaded single tooth implants in 14 patients, which loaded within 24 hours after surgery with temporary crowns. These preliminary data showed also 14 percent failures after a five-month loading period.[15]

In contrast to the data from the single tooth immediately loaded implants, the authors were able to get a high success rate when restoring complete jaws using six to eight immediate implants splinted together with temporary cross-arch jaw restorations immediately after placement. The main criteria of success was the excellent primary stability and the immobilization using a stable temporary bridge.

The present clinical data shows an impressively high success rate using this treatment protocol after clinical loading of the implant for a period of two years. This treatment concept has been used to date in 16 patients with 138 immediate implants (78 in the maxilla and 40 in the mandible) loaded immediately after surgery. After a loading period of 16.18 ±9.34 months, three immediate implants and immediately loaded were lost (data not shown). This represents a success rate of 97.82 percent using an implant system with a progressive thread design and sandblasted rough surface. The failed immediate implants were placed in combination with simultaneous sinus lift procedure and loaded immediately.

There is no doubt, that special training in advanced periodontal and implant surgery as well as implant prosthodontics will help the dentist to reach high success rate and long-term prognosis in such treatment protocols. A high number of clinical studies are necessary, before these techniques may be used on a routine basis. The excellent primary stability of the selected implant system is a conditio sine qua non in order to get in the future scientific data with more evidence.

High Risks for Immediate Loading Treatment Concepts

General contraindications for immediate loading seem to be patients with inadequate compliance for recall visits, and patients with parafuntional habits. This is relevant when patients do not adhere to a soft diet in the first period of healing. Patients with parafunctional habits such as bruxism also should be considered as a high-risk group for immediate loading since it was shown that overloading may change the bone-to-implant interface dramatically.[42] It has been shown that the failure rate in patients with bruxism with immediately loaded implants was about 37 percent.[9] There were more failures (41 percent) in comparison to nonbruxers (12 percent) have been reported by Glauser et al.[17] Since it has been considered that bruxism reduces the success rate of implant therapy, bruxers should be treated using the conventional loading protocol.[43]

Rigid splinting and minimal force applications are critical factors for the success in immediately loaded implants, according to Tarnow et al.[10] The authors recommend avoiding the removal of the provisional prosthesis in the first four to six months of healing if these restorations are cemented. This view

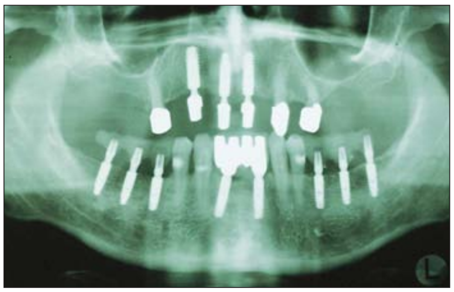


Figure 1e. Radiological examination at the left side (immediately loaded implants) and right side shows no bone loss with the provisional restorations.

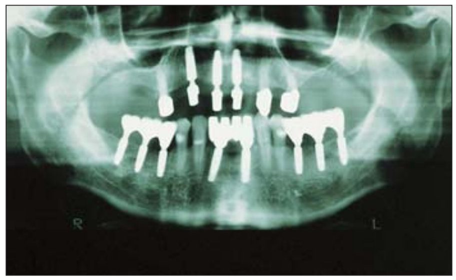
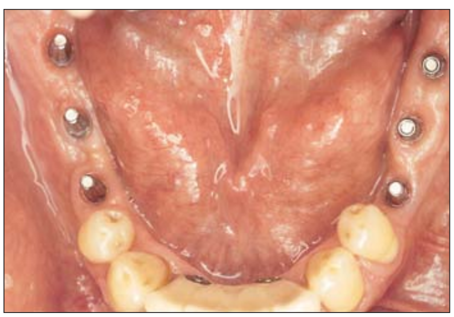


Figure 1f. No bone loss on the immediately and delayed loaded implants.



Figures 1g and h Peri-implant healthy soft tissue condition three years after loading as well as excellent esthetics.

Figure 1h.

corresponds with additional studies performed by Horiuchi et al.[11] Moreover, most failures are reported in the posterior part of the mandible.

This is probably because of the poor bone quality in this area and the lack of contact of the implant with the opposing cortex.[10-11,22] Systemic factors, like heavy smoking and local anatomical factors, such as extensive augmentations in areas of poor bone quality in the maxilla have been discussed as critical factors lead to complications during immediate loading.

The following clinical case reports present a concept of immediate loading in three patients in order to demonstrate the applied surgical and prosthetic treatment protocols and provide the clinician the basis for a successful immediate loading concept with a long-term success.

Case Presentations

Case No. 1

A 59-year-old Caucasian male patient with bilateral free-end edentulism in the lower jaw received six Ankylos implants, three on each side (**Figure 1a**). One side of the mandible, the implants were loaded after three months of healing. On the contralateral side, three implants were loaded immediately with temporary splinted crowns (**Figures 1b-d**). The provisional restorations were placed on both sides in the same time and had occlusal contacts. The radiographical examination immediately after installation of the splinted provisional crowns is presented in **Figure 1e** showing the marginal bone level. The final restorations placed 5½ weeks after surgery. After three years, the bone level was the same. No bone loss was able to be observed in the delayed and immediately loaded sides (**Figure 1f**). The clinical peri-implant soft tissue condition around the Ankylos implants was healthy and the occlusal surfaces of the implants had a conventional occlusal shape representing excellent esthetics.

Case No. 2

A 60-year-old Caucasian female edentulous patient was consulted because of insufficient retention of her lower jaw denture. In the prior six months, the patient received new dentures from her home dentist but was unhappy with the retention in the lower jaw. The patient ultimately decided for a fixed implant-supported bridge. A radiological examination showed sufficient bone height. The full dentures were in an acceptable functional and esthetic condition. The vertical and horizontal dimensions were good. An impression of the lower jaw denture was taken in order to fabricate surgical guide splint for the lower jaw.

Surgical Procedure

A crestal incision was performed under local anaesthesia in order to place Ankylos implants (Dentsply-Friadent Co., Mannheim, Germany). Mucoperiosteal flap elevation was performed and the alveolar ridge was exposed. The thin alveolar ridge in the anterior part of the mandible was reshaped using a diamond bur under sterile saline cooling. A bilateral preparation of the N. mentalis was performed in order to avoid surgical damage during implant placement. The plateau of the alveolar ridge in the symphysis was

Figure 2a. Edentulous mandible for immediate loading. Implant placement and abutment connection for immediate loading using a provisional bridge and immediate functional loading. Mucoperiosteal flap elevation in the upper jaw presenting the narrow alveolar ridge.

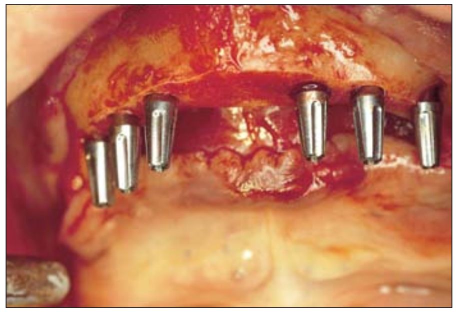


Figure 2b.

Figure 2c.

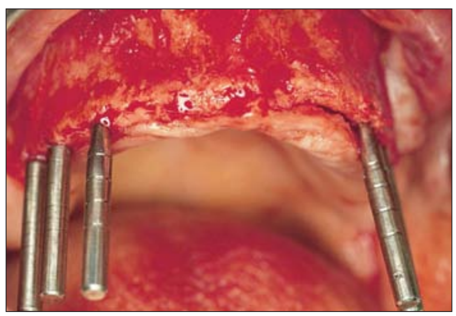


Figure 2d.

sufficient in order to place six implants in the areas Nos. 21-23 and 26-28 without any augmentative surgical procedures. We placed implants with a progressive thread design (Ankylos, Dentsply-Friadent Co., Mannheim, Germany) for a high primary stability using a surgical guide splint during drilling. The implants had a sandblasted surface and a highly polished collar of 2 mm. The length was 14 mm and the diameter 3.5 mm. The implants were connected with their standard straight abutments immediately after surgery (**Figure 2a-b**). The abutments were fixed with a torque of 20 NCM as has been recommended for this implant system. Periotest values were evaluated to record implant stability immediately after implant placement and abutment connection (PVo). Temporary caps were placed and fixed in position with Temp-Bond cement material (Kerr Co., Karlsruhe, Germany) and the mucoperiosteal flap was sutured with 4-0 silk suture material (Resorba Co., Nürnberg, Germany).

Postoperative Care and Prosthetic Rehabilitation

Immediately after surgery, a temporary fixed bridge reconstruction was fabricated chairside with Pro-Temp acrylic material (Espe Co., Seefeld, Germany) using an acrylic template and cemented on the abutments having occlusal contacts in centric (**Figure 2c**). The relining of the template was performed in centric occlusion, in the correct vertical dimension. An orthopantomograph was performed to evaluate the peri-implant crestal bone level after surgery. The patient was advised to use a soft diet for the first four to six weeks. Rinsing of the oral cavity with chlorhexidine digluconate 0.2 percent solution for chemical plaque control was indicated until the sutures were removed. Ten days after surgery the sutures were removed. Four weeks after implant placement and loading, the peri-implant soft tissue showed a healthy color. Impressions were performed using Impregum (Espe Co, Seefeld, Germany) and special transfer caps using customized trays. An implant-supported metaloceramic reconstruction was fabricated and cemented temporarily with Temp-bond two weeks later. Cantilevers were used for the second premolar and first molar in order to establish a first molar occlusion.

Four months after loading, the patient asked for similar treatment in the upper jaw. Using a similar surgical guide splint for the lower jaw surgical procedure, a mucoperiosteal flap elevation was performed with midcrestal incision under local anesthesia. The alveolar ridge

Figure 2e. Implants placed and connected with their abutment for immediate loading. An additional autogenous bone grafting procedure was necessary as well as a coverage with a Biogide membrane (GBR technique) to cover the implants with bone.

Figures 2f-h. Healthy peri-implant soft tissue around the immediately loaded implants three years after surgery as well as bone stability characterizes the long-term success of the immediate loading concept also in compromized clinical sites.

Figure 2g.

Figure 2h.

was relatively thin (approximately 2 mm to 3 mm width) for the optimal implant placement (**Figure 2d**). The implants were placed using the protocol for the Ankylos implant system in the areas Nos. 4-6 and 11-13. The implants had 14 mm length and 3.5 mm diameter. All implants had excellent primary stability but some of the threads in the buccal aspect were exposed and needed augmentation. Autogenous bone graft was harvested from the two tuberosities using a trephine and milled with a milling machine before augmentation of the exposed implant threads. Temporary resin abutments were placed in order to check the parallelity and then replaced with the definite angulated abutments using controlled torque according to the Ankylos implant protocol (**Figure 2e**). Finally, all implants were covered with one Biogide collagen membrane (Geistlich, Wolhusen, Switzerland), which was fixed in place with titanium pins (Frios, Friadent, Mannheim, Germany). The flap was sutured in place and a temporary arch-shaped fixed bridge without cantilevers was fabricated chairside. Periotest values were evaluated immediately before installation of the bridge and postoperative care instructions were given to the patient as has been reported previously for the lower jaw. A symmetrical arch-balanced occlusion with the temporary fixed reconstruction was used in centric occlusion without any eccentric contacts in the lateral movements. One week after surgery, the sutures were removed. The impression for the final implant-supported fixed restoration was taken four weeks after surgery using a similar impression technique as in the lower jaw.

The patient was re-examined every three months, the restorations were removed and clinical mobility index (Periotest) evaluated along with the implant soft and hard tissue condition.

The final follow-up examination three years after surgery in the lower jaw (2.5 years after loading in the upper jaw) showed excellent soft tissue in all of the peri-implant areas as well as an esthetic result (**Figures 2f-g**). A marginal bone loss could not be observed in any of the implants. The Periotest values at the baseline (PVo), at the time of the bridge installation (PV) as well as at the final follow-up examination (PV1) after removal of the prosthetic restorations were as follows:

PVo: 2±3.83 (baseline)

PV: –1.33±2.5 (placement of final restorations)

PV1: –1.41±2.75 (three-year loading period)

Figure 3a. Anterior view.

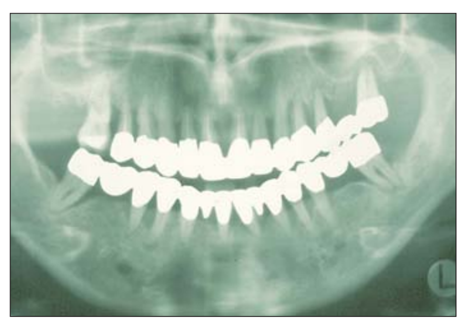
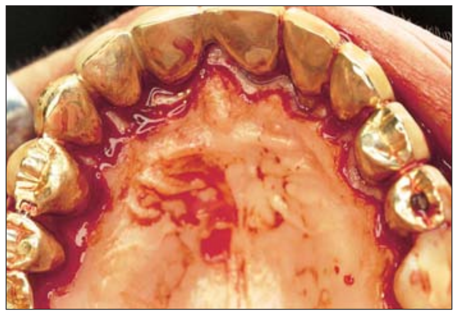


Figure 3b. Radiological examination presenting the advanced periodontal destruction in the upper and lower jaw teeth.

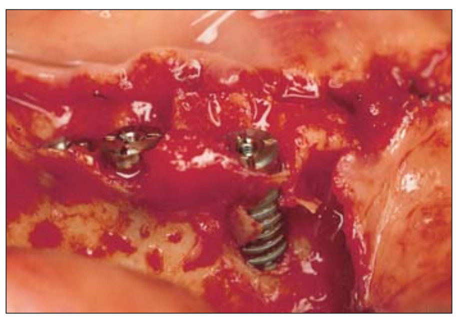
Case No. 3

A 49-old-female patient was referred because of mobility of the upper and lower jaw teeth. All teeth presented advanced periodontal disease and the patient was informed about the bad tooth prognosis and the possibility of an implant-supported restoration (**Figures 3a-b**). The patient was unable to accept a full denture for psychological reasons and, therefore immediate implants and immediate functional loading were recommended. A mucoperiosteal flap elevation was performed, and all the periodontally involved teeth were extracted (**Figure 3c**). Eight immediate implants in the upper and eight in the lower jaw were placed with high primary stability (**Figures 3d-e**). The implants were connected with their abutments and splinted together with a provisional fixed prosthesis immediately after surgery. Augmentation with autogenous bone grafting materials (GBR technique) was necessary in some areas to increase the stability of the immediate implants (**Figures 3f-g**). For the initial stages of the healing, the patient used a soft diet. After osseointegration, an impression was done for customized abutments and fabrication of the final restoration. The dental lab fabricated metal-ceramic fixed implant-supported restorations on customized abutments in order to improve esthetics and function. The soft tissue peri-implant condition as well as the bone level was stable during the two-year loading period (**Figures 3h-l**).



Figures 3c and d. Surgical access in order to remove the periodontally involved teeth and inflamed tissues and placement of eight primary stable Ankylos implants in the correct areas.

Figure 3d.



Figures 3e and f. Fenestrations and bony defects were grafted with autogenous bone grafting material and covered with a Biogide membrane.

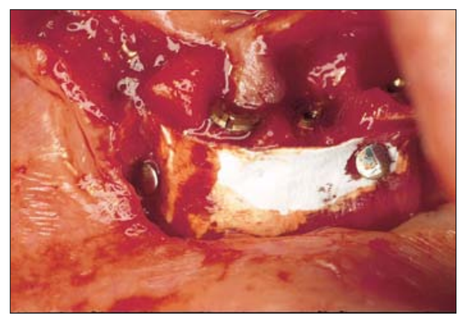


Figure 3f.

Figure 3g. The immediate implants loaded immediately after surgery with provisional fixed implant-supported restorations (functional loading) keeping the vertical dimension.

Figures 3h and i. The peri-implant soft tissue was healthy two years after surgery.

Figure 3i.

Figures 3j and k. An excellent esthetic result was possible using fixed metaloceramic restorations.

Figure 3k.

Figure 3l. The final radiological examination presents stability of the peri-implant bone without any bone loss during the two-year immediate loading period. (Dental technician: M. Funk, MDT, Bad Vilbel, Frankfurt, Germany.)

Discussion and Conclusions

These case reports demonstrate an immediate loading protocol for dental implants in edentulous patients using fixed implant-supported restorations. They also illustrate a treatment protocol and allow a clinician to treat patients using this loading concept with a minimum number of implants (six in each jaw) in edentulous cases.

There are many considerations for successful immediate loading. One of the requirements is the primary stability of the placed implants, which is dependent on the macro- (implant shape, screw geometry) and micro-design (surface pattern) of the implant, the quality of the implant bed preparation, quality and quantity of the bone, as well as the implant length and diameter.

Screw-shaped implants are recommended for immediate loading, because they permit mechanical stability in bone immediately after their placement. Implants placed in poor quality bone should be inserted without tapping for additional initial stabilization or osteoplastic techniques of bone condensing for implant bed preparation should be used.

The primary stability is associated with a high number of bone-to-implant contacts immediately after implant insertion. An implant is considered as osseointegrated at the histological level when a bone-to-implant contact of more than 60 percent is observed histologically after healing.[44] Moreover, values of BIC less than 25 percent are associated with clinically stable fixtures.[45-46]

In the present clinical case reports, the authors used an implant system with progressive thread designed geometry because of the high primary retention.[47] It had been demonstrated histomorphometrically in cadavers to have high percentages of bone to implant contacts immediately after implant insertion.[48]

By increasing the implant surface area by means of rough surfaces and special thread geometry, it is possible to successfully load small-sized implants (3.5 mm diameter and short implants). Implants with such progressive thread geometry have a total surface similar to multirooted teeth.[49] Therefore, Ankylos implants were used successfully for single molar replacement.[50]

A further requirement for implant success (when implants are loaded immediately) is immobilization in order to eliminate micromotion in the interface.[5-6,11,20-21] This immobilization is extremely important in all of the stages of treatment. CDA

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Implant Designs for the Spectrum of Esthetic and Functional Requirements

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ABSTRACT

In recent years, attention has shifted from merely achieving successful osseointegration of dental implants to achieving proper esthetics that mimic natural dentition. Original implant designs were primarily developed for the treatment of fully edentulous patients where esthetics was not a major objective of the therapeutic outcome. During the initial years of the development of osseointegrated implants, greater emphasis was placed on achieving successful osseointegration. As the number of patients undergoing implant therapy, as well as the number of clinical indications for dental implants, is rapidly expanding, the therapeutic armamentarium also has to expand. The most important requirement for achieving predictable esthetic results is careful consideration of the biology of the interaction between the implant-prosthesis complex with the implant site. Only those implant-supported restorations that achieve harmony with the surrounding hard and soft tissues can be expected to have an optimal esthetic outcome will endure.

The explosion in implant dentistry has been accompanied by an increase in the number of dental implant manufacturers and the dental implant designs available. Today a variety of dental implants are available with many more in development. Many of the implants have incorporated novel design features to respond to the variety of esthetic and functional requirements (**Table 1**). The term "root form" was designated at the 1988 National Institutes of Health consensus development conference to endosseous implants which are variations of a cylinder and are inserted vertically into the alveolar process.[1] Root form endosseous implants vary in design including the implant body shape, the prosthetic interface (platform), the presence or absence of threads, as well as other design features.[2,3] Root form dental implants can be categorized into threaded and non-threaded (press-fit). Implant shapes

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Table 1

Implant Design Features

Implant aspects	Implant Design features				
Body	Cylindrical (parallel-walled)	Tapered	Stepped		
Insertion mechanism	Threaded	Press fit			
Prosthetic interface (Platform)	Flat	Scalloped	Anatomic		
Implant –abutment connection	External connection	Internal connection	One piece		
Surface characteristics	Machined	Subtractive textured surface (acid etched, blasted)	Additive textured (HA coated, sintered)		
Additional design features	Microthreads	Ridges	Grooves	Flutes	Vents

include parallel-walled, tapered or stepped contour and can be hollow or solid, The design of apical ends of implants include flat, round or pointed. A variety of other design features have been incorporated in dental implants primarily to increase their stability and to reduce compressive forces during insertion. These features include grooves, vents, microthreads, ridges, flutes, and indentations, as well as perforations.

A systematic comparison of various implant systems is lacking in the literature. Many of the manufacturers' claims, as intuitive as they may be, have not been substantiated with rigorous research. Therefore, the selection of a particular implant system may in part rely on the availability of preliminary data and in part based on the experience and preferences of the clinician.

Implant Restoration in the Esthetic Zone

In the esthetic zone, where the requirements are more demanding, a variety of biologic and anatomic factors have to be taken into account in treatment planning patients. Becker, et al. have analyzed the alveolar bone morphology on dry skulls to define three distinct anatomic morphotypes.[4] These included flat, scalloped and pronounced scalloped anatomic profiles according to alveolar bone anatomy (**Figure 1**). It was suggested that tooth extraction in patients with thick-flat anatomic profiles merely may lead to subtle changes in hard and soft tissues. However, marked hard and soft tissue defects may result after extraction in patients with thin-scalloped profiles. These changes may result in significant deformities of bone height and width, which pose esthetic challenges for restoration. Therefore, in order to replace teeth with different anatomic hard and soft tissue morphotypes, different implant designs may be required. The conventional cylindrical implants with a flat platform are appropriate for flat anatomic profiles. However, replacement of teeth in patients with scalloped profiles of hard and soft tissues may require specialized implant designs.

In treating patients with scalloped profiles, there is significant distance between the crest of the papilla and the mid-facial zenith gingival height of contour. Therefore, preserving and maintaining the papilla is a challenge to the clinician and requires an in-depth understanding of the anatomy and biology of the hard and soft tissues. Tarnow et al.

Figures 1a-c. Anatomic morphotypes. Soft tissue and bone anatomic morphotypes include flat, scalloped or pronounced scalloped.

Figure 1b.

Figure 1c.

have performed a systematic analysis of inter-implant papillary heights and have demonstrated that the mean height of papillary tissue between two adjacent implants is 3.4 mm.[5] In many patients with a scalloped profile, the height of papillary tissue is greater than 3.4 mm. Therefore, when placing two adjacent implants in the esthetic zone, clinicians should consider this distance and plan their treatment accordingly. In sites with pre-existing crestal bone loss, augmentation of the bone height prior to implant placement in anticipation of the final location of the bone crest is required for optimal esthetic outcome. In many cases, the crestal bone loss has to be overbuilt, in an effort to end up within the 3.4 mm, which is the estimated location of papilla.

In order to preserve and maintain the interproximal papilla, it will be required to preserve and maintain the underlying bone. This is of particular importance in the esthetic zone, where interproximal bone loss between adjacent implants/teeth may lead to the loss of papillary height. The papilla between two adjacent implants is affected by the design of the coronal portion of the implant, as well as the location and contour of the implant-abutment interface. Another important factor in preserving the papilla around implants has to do with the distance between an implant and its adjacent tooth/implant. Tarnow et al. have demonstrated increased crestal bone loss when two adjacent implants were placed with less than 3 mm distance between.[5-7] These investigators have recommended that when multiple implants are planned in the esthetic zone, a minimum of 3 mm of distance to be allowed between them at the implant-abutment level.

The morphology and dimensions of natural roots have been compared to those of conventional cylindrical implants, demonstrating a significant discrepancy.[8] Recently, Gallucci et al. examined the dimensions and characteristics of the cementoenamel junction of maxillary anterior teeth and compared the natural CEJ to current implant designs.[9] These investigators found tooth-implant biologic width discrepancies ranging from 4 mm to 6 mm. Therefore, it is clear that cylindrical, conventional implant designs exhibit significant discrepancies with the dimensions of natural teeth. These authors concluded that the existing implant design featuring a flat platform should be reconsidered in view of natural CEJ contour to improve biologic considerations and related esthetics.

It is clear that cylindrical, conventional implant designs exhibit significant discrepancies with the dimensions of natural teeth.

A comprehensive review of implant design is beyond the scope of this article. The present review will discuss a few of the novel alternative implant designs, which may have utility in more demanding clinical applications, with special emphasis on the esthetic zone.

Tapered Implants

One of the indications for tapered implants has been in soft quality bone. The survival rate of dental implants in soft quality bone has been demonstrated to be lower than that of implants inserted in dense bone. Therefore, tapered implants were developed in an attempt to increase primary stability of implants.

Although increased primary stability has been demonstrated with some designs of tapered implants, the success rate of tapered and cylindrical implants were in one study demonstrated to be equally high (>96 percent).[10,11]

Another indication for the tapered design is proximity to anatomic structures. In alveolar ridges with concavities or proximity to other anatomic structures in the apical third of implant site, tapered implants are less likely to produce a dehiscence or impinge on those anatomic structures than cylindrical implants.

In the clinical case illustrated in **Figure 2**, a 65-year-old female presented with a severely carious tooth No. 9. Clinical evaluation of the soft tissue morphotype revealed a flat topography. Analysis of the osseous topography revealed the presence of concavity of the alveolar process near the apical area of the tooth.

Due to the flat morphotype, an implant with a flat platform was selected and the presence of apical concavity necessitated selection of a tapered implant body design. Following atraumatic extraction, a tapered implant with an internal prosthetic connection (Sterios Replace Select Tapered, Nobel Biocare) was placed.

The current recommendation for this type of implant placement requires slightly more palatal location. The implant was placed with the platform nearly 2 mm apical to the gingival margin. When properly placed the implant does not need to be submerged too far apically. The definitive abutment was connected followed by immediate provisional placement.

Figure 2a.

Figure 2b.

Figures 2a-d. Clinical case utilizing the tapered implant. A 65-year old female presented with a severely carious tooth No. 9. Clinical evaluation of the soft tissue morphotype revealed a flat topography. Analysis of the osseous topography revealed the presence of concavity of the alveolar process near the apical area of the tooth. Due to the flat morphotype, an implant with a flat platform was selected and the presence of apical concavity necessitated selection of a tapered implant body design. Atraumatic extraction, showing preservation of the hard and soft tissues in the extraction site. Placement of a tapered implant with an internal prosthetic connection (Sterios Replace Select Tapered), using a minimally invasive approach. The implant platform was placed only 2 mm apical to the gingival margin, thus avoiding impingement of the biologic width.

Figure 2c.

Figure 2d.

Figure 2e.

Figure 2f.

Figures 2e-h. The definitive abutment was connected, showing facial and occlusal views. Radiograph of the implant and abutment, showing 2 mm of distance between implant platform. Fabrication of the provisional restoration. Marginal adaptation of the provisional to the abutment, as well as contours and high polish near the cervical area are critical factors for immediate restoration of implants.

Figure 2g.

Figure 2h.

Figure 2i. Provisional cemented. It is also critical to assure absence of any cement extending beyond the margin.

Figure 3a. Clinical case utilizing the scalloped implant. Sixteen-year-old female, who was congenitally missing tooth No. 10, underwent orthodontic therapy to open the space for tooth No. 10.

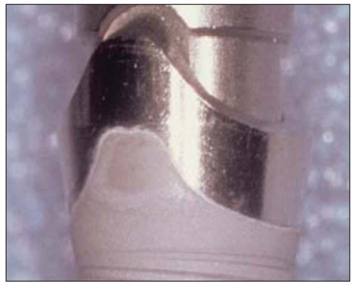

Figure 3b. The platform of the scalloped implant. The platform has a facial leve, which is more apical than the interproximal area to follow the anatomic contour of the alveolar bone crest in the anterior area.

Figure 3c. A scalloped implant was placed.

Figure 3d. Clinical view of the abutment.

Figure 3e. Radiograph of the abutment.

Figure 3f. Clinical view of the provisional.

Scalloped Implant

In an attempt to address the problem of tooth replacement in sites where the alveolar morphotype is scalloped, modifications to the implant platform have been introduced. The scalloped implants feature a platform which is raised in the interproximal areas and is lowest in the mid-facial and mid-lingual areas. The rationale in the design of the scalloped design is to more closely follow the contour of the CEJ. This has been proposed to assist in preserving the interdental bony peaks that support the soft tissue, thereby maintaining inter-implant papillae.[12] The scalloped implant, which is treaded in design provides two positional opportunities per rotation, to allow proper positioning of the interproximal height of contours. A clinical case utilizing the scalloped implant is presented in **Figure 3**. The case illustrates a 16-year-old female, who was congenitally missing tooth No. 10 and had undergone orthodontic therapy to open the space for the tooth. A scalloped implant was placed followed by abutment connection and provisional restoration.

Anatomic Implant

Another alternative implant design has been the development of the anatomic implant system. This is an implant system that has been in development with the underlying rationale to more closely mimic the dimensions and form of natural dentition.

The problem with cylindrical implants with a flat platform is the discrepancy between their shape and that of natural teeth (**Figure 4**). In restoring implants with a cylindrical flat platform, the prosthesis has to compensate for this discrepancy by incorporating contours that span the transition from the implant to the cervical region. The region of the prosthesis spanning the implant platform to the cervical area of the prosthesis has been termed "the transition zone." The contour of the transition zone will dictate the emergence profile of the prosthesis.

In situations where the discrepancy between the implant platform and the prosthesis is great, prostheses with unfavorable transition zone contours may have to be fabricated, such as one with a "ridge lap" contour. Some surgeons have attempted to compensate

Figure 4a. Comparison of the conventional threaded parallel-walled implant with anatomic implant. Conventional implant with flat platform exhibits significant discrepancy in its size and shape with that of the boney crest and the CEJ of the tooth it is replacing.

Figure 4b. Comparison of the cross-section of a conventional implant with a maxillary central incisor, showing significant discrepancy. Superimposition of an anatomic implant over the longitudinal section of a maxillary central incisor.

Figure 4c. The platform of the anatomic implants follows the rise of the CEJ in the interproximal area. The facial level is more apical than the interproximal area.

Figures 4d-f. Cross-section of different anatomic implants, showing maxillary incisor, mandibular incisor, and posterior canine implants.

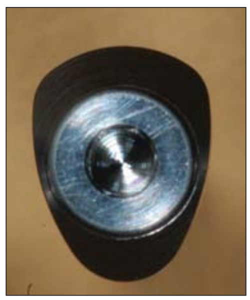

Figure 4e.

Figure 4f.

Figure 5a. Clinical case utilizing the anatomic implant. Missing tooth No. 5.

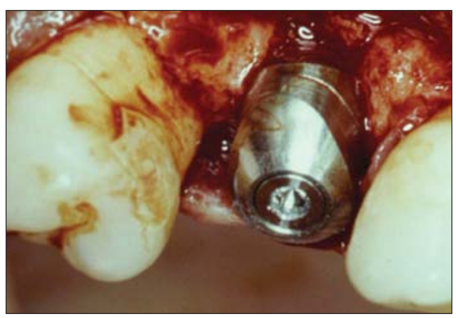

Figure 5b. Surgical placement of an anatomic implant.

Figure 5c. Healing abutment.

Figures 5d-f. Radiograph of the restored implant. Restoration of the implant in 1996 and followup six years later showing stable peri-implant tissues.

Figure 5e.

Figure 5f.

Figure 6b.

Figures 6a and b. Clinical case utilizing the one-piece implant. Preoperative clinical view and radiograph of missing mandibular central incisor.

Figure 6d.

Figures 6c and d. Clinical and radiographic views following placement of a 3.0 mm one-piece narrow diameter implant, using a minimally invasive approach.

Figure 6e. Immediate fabrication of a provisional restoration with no occlusal contacts.

for this unfavorable discrepancy by placing the implant more apically. In the short term, this will allow the restorative dentist more space to gradualize the contour in the transition zone. However, in the long run, implants placed too far apically will exhibit more crestal bone loss and there is the possibility of either recession or pocket formation with accompanied risk of abscess formation. The initial attempt to incorporate the 3-D geometry of root morphology into implant components was anatomically-configured abutments.[13] The anatomic implant is the next step in the progression toward implant components which mimic natural teeth. This system features three implant designs for different regions of the mouth (**Figures 4d-f**). The maxillary and mandibular incisor designs are triangular in cross section. The posterior design is oval in cross section. These implants also have a sloped inclination with the facial margin more apically located than the lingual margin. The anatomic implant, which is press-fit in design offers complete flexibility of vertical, as well as rotational positioning during insertion.

The clinical case in **Figure 5** is a 54-year-old female missing tooth No. 5. A posterior anatomic implant was placed. Restoration and follow up illustrate stability of the peri-implant tissues during the six-year follow-up.

One-piece implants

There are a number of animal studies that have analyzed the response of hard and soft tissues to the presence of the implant-abutment interface. These studies have suggested that the one-piece non-submerged implants have a more favorable hard and soft tissue response, since the biologic width dimensions are more similar to natural teeth.[14,15] In comparison, two-piece implants have been shown to induce more crestal bone resorption, presumably because a biologic width establishes between the bone and the implant-abutment interface. This has been used as a rationale for development of one-piece implants.

Another advantage of one-piece implants is the ability to fabricate fixtures with very narrow diameters, such as the implant with 3.0 mm diameter. Implants with very narrow diameters have application for the mandibular anterior, maxillary incisor or other situations with limited space. The limitation of one-piece implants is the fact that the orientation of implant and abutment portions of the implant are in one line. This limits the ability to change the orientation of the prosthetic portion, compared to two-piece implant designs, where angled abutments can be utilized.

The clinical case illustrated in **Figure 6** is a 48-year-old male with a missing mandibular central incisor. There available space for the missing tooth was only 7 mm. This space was merely adequate for a very narrow implant of 3 mm in diameter. Accordingly, one-piece narrow diameter implants (Nobel Direct) were placed and immediately provisionalized.

Conclusion

The increased application of dental implants has been accompanied by a surge in the availability of an array of different implants, some with novel design features. Manufacturers of dental implants have proposed that the introduced design features offer improvements over previous dental implant designs. Much research will be required to substantiate all of the claims. However, the availability of the multitude of implant designs has provided clinicians with more choices to select the appropriate implant type for a given clinical situation. CDA

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Implant Site Development: Clinical Realities of Today and the Prospects of Tissue Engineering

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ABSTRACT

The success of dental implants depends on their placement in bone of adequate density and volume in order to achieve primary stability. Optimal esthetics of implants requires their placement in a position approximating that of the natural teeth they replace. However, there is generally at least some degree of atrophy in the sites where implants are to be placed. This atrophy may occur either before or after tooth extraction. Following extraction of teeth, there is commonly alveolar ridge resorption in horizontal and vertical dimensions. Alternatively, some of the oral hard and soft tissues may be destroyed by pathologic conditions such as periodontitis, endodontic infections, or trauma. All of these conditions may potentially compromise the final esthetics and function of implant-supported restorations. During the initial years of the development of the osseointegration protocol, implants were placed with little or no modification of implant sites.

Though osseointegration was successfully achieved, esthetic outcome was not a primary objective of therapy at that time. A gradual paradigm shift has occurred in implant dentistry from merely achieving successful osseointegration to achieving final restorative outcomes that mimic natural dentition and their surrounding oral tissues. These objectives have been materialized by advancements in surgical techniques, as well as availability of biomaterials to enable predictable regeneration of oral hard and soft tissues. The objective of the present review is to briefly discuss some of the techniques that are currently available for implant site development.

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There are many circumstances where the implant site has inadequate horizontal width or vertical height for proper placement of dental implants. Although it may be possible to place implants in such sites with a deficient ridge, the restorative outcome is likely to be compromised. The reason for the unacceptable results may be that the interarch distance may be too large or the position and direction of implants may be unfavorable. One of the most predictable methods to increase the width and height of the alveolar bone is the utilization of "onlay block bone graft."

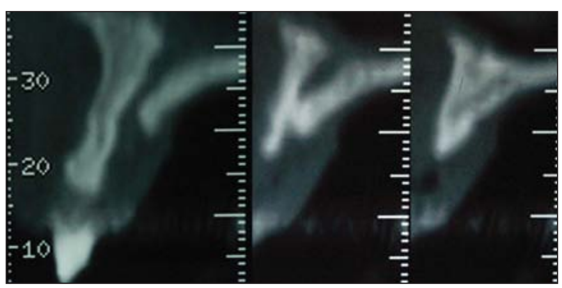
This augmentation procedure will facilitate placement of implants in optimal position for proper prosthesis construction. This procedure entails harvesting a block of bone and fixating the block on the implant site by means of mini fixation screws. Both intraoral, as well as extraoral sites have been used as sites for harvesting donor bone. Intraoral sites include anterior ramus of mandible or symphysis area of the chin. Extraoral sources have also been used to harvest bone, including iliac crest, calvaria, as well as tibia. The bone block and/or the recipient beds are usually modified to achieve intimate contact between the bone block and the recipient site. The healing time can vary from three to six months to ensure proper fusion of the graft with the recipient bed. Autogenous onlay block grafting has been thought to be the gold standard for achieving horizontal and vertical bone augmentation. However, randomized, controlled clinical trials to compare the efficacy of various augmentation techniques are scant. There is not enough evidence to demonstrate superiority of any particular technique.[1]

Clinical Case No. 1

A clinical case using onlay block graft technique is illustrated in **Figure 1**. This patient presented after unsuccessful attempt at implant placement. The original implant in site of tooth No. 9 was placed far too facially and did not integrate and as a result produced significant damage to the edentulous ridge. CT scan images revealed significant atrophy of the ridge, as

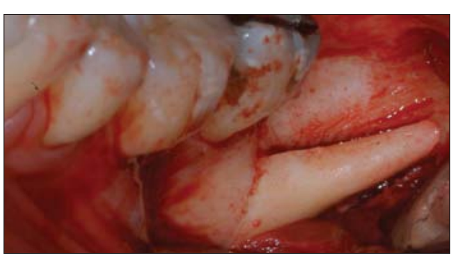
Figures 1a and b. Regeneration of the alveolar ridge by onlay block graft. Patient presented with a failed implant in site of tooth No. 9 that had caused severe ridge atrophy.

Figure 1b.



Figures 1c and d. CT scan confirmed the alveolar bone atrophy, as well as the proximity to the incisive canal. Mucoperiosteal flap was reflected, showing the position of the ridge crest.

Figure 1d.



Figures 1e-i. Donor site was the left anterior mandibular ramus. Block graft harvested, recontoured and fixated to the recipient site with mini screws. Flap was sutured.

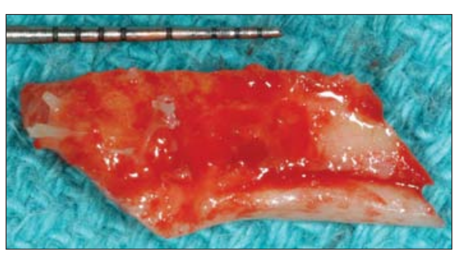


Figure 1f.

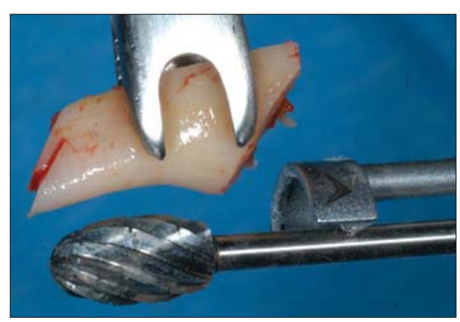


Figure 1g.

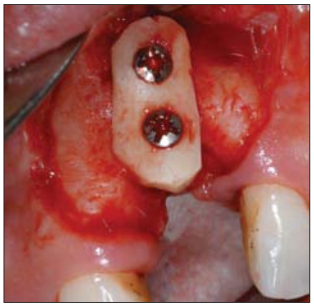


Figure 1h.

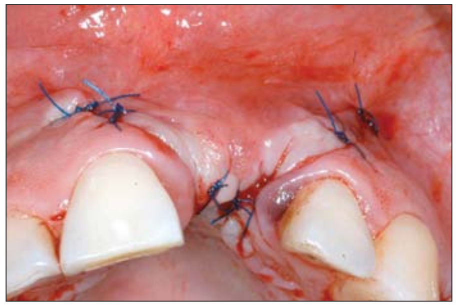


Figure 1i.

Figure 1j. Removable temporary appliance in place showing significant horizontal and moderate vertical augmentation of the ridge.

well as proximity to the incisive canal. To augment the site, a mucoperiosteal flap was reflected, confirming severe ridge resorption. A block bone graft was harvested from the left mandibular ramus and fixated to the recipient site with mini screws. Healing results show significant horizontal and moderate vertical augmentation of the ridge.[2]

Guided-Bone Regeneration

An alternative method for achieving horizontal and/or vertical augmentation of bone is guided-bone regeneration. The main difference between this technique and onlay block grafting is the utilization of particulate bone in guided-bone regeneration. In general, bony defects that are within the alveolar housing can be successfully treated with either onlay block grafting or guided-bone regeneration. However, for defects that extend beyond the confines of the alveolar crest, onlay block grafting achieves more predictable results. A variety of bone graft materials have been used in a particulate form, including autogenous and allogenic, as well as alloplastic ceramics. The particulate bone is retained in the desired position with the aid of a barrier membrane, which serves several functions, including containment of the particulate bone in the desired location, wound stabilization and provision of a space under the mucosa to allow host bone to fill in. There are a number of different types of membranes used, both resorbable and nonresorbable. Some membranes have metal reinforcement such as the titanium-reinforced membranes.

For defects that extend beyond the confines of the alveolar crest, onlay block grafting achieves more predictable results.

Clinical Case No. 2

The case in **Figure 2** illustrates application of GBR in bone augmentation. The patient in Figure 2 presented with tooth No. 11, which was fractured into three fragments. The tooth exhibited suppuration. Tooth No. 12 had a failed root canal. Following extraction of teeth Nos. 11 and 12 severe bone loss was noted around their extraction sockets. The soft tissue and bone were allowed to heal for approximately eight weeks. During the healing, severe ridge deficiency in both horizontal and vertical dimensions was noted. When implants were placed in sites of teeth Nos. 11 and 12, significant dehiscence was present on facial of the implant in site No.11 with exposure of six threads on its facial aspect and one thread on facial aspect of No. 12 (**Figure 2d**). An expanded-polytetrafluoroethylene membrane was fixated on the facial ridge to contain the particulate bone graft and provide tenting effect to support the facial ridge regeneration (**Figure 2e**). Freeze-dried bone allograft was placed around the implants to cover the exposed implant threads (**Figure 2f**). Primary closure of the surgical site achieved with ePTFE suture (**Figure 2g**). The implants were exposed and the membrane was removed after four months (**Figure 2h**). The previously exposed implant threads were completely covered with bone and anatomically optimal ridge form was present. This would lead to a much more optimal tissue contour in the final restoration.

Orthodontic Extrusion

A nonsurgical alternative for increasing the amount of available bone for implant site development is orthodontic extrusion or forced eruption.[3] When teeth are moved in a coronal direction

Figure 2a. Guided-bone regeneration. Patient presented with fractured tooth No. 11, which exhibited suppuration.

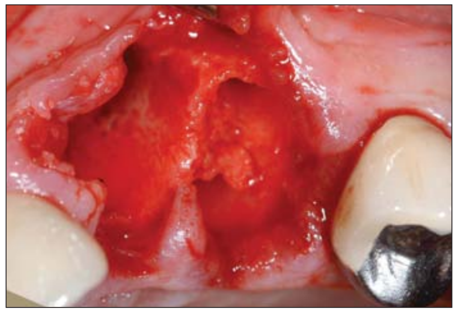


Figure 2b. Teeth Nos. 11 and 12 were extracted, showing severe bone loss around the extraction sockets.

Figure 2c. The soft tissue and bone were allowed to heal for approximately six weeks. Note severe ridge deficiency in both horizontal and vertical dimensions.

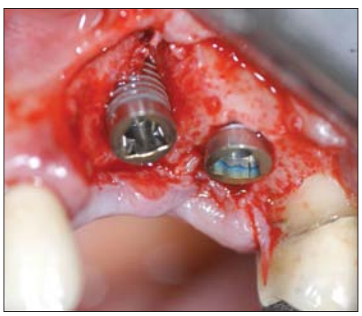


Figure 2d. Implants placed in sites of teeth Nos. 11 and 12 showed exposure of six threads on facial aspect of implant No. 11 and one thread on facial of No. 12.

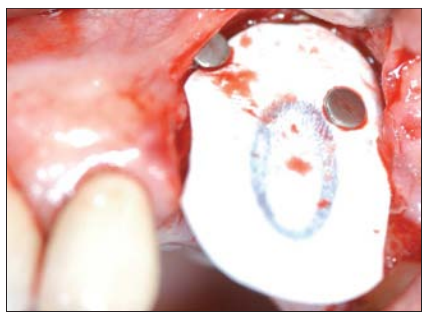


Figure 2e. An expanded polytetrafluoroethylene membrane was fixated on facial ridge of the extracted teeth to contain the particulate bone graft and provide tenting to support the facial ridge regeneration.

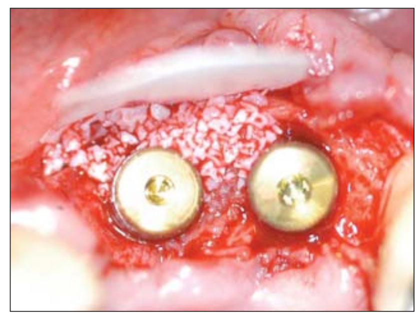


Figure 2f. Freeze-dried bone allograft was placed around the implants to cover exposed implant threads.

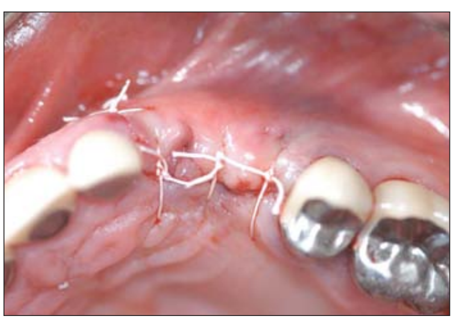


Figure 2g. Primary closure of the surgical site achieved by suturing with ePTFE suture.

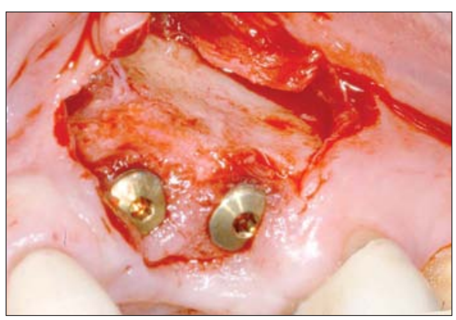


Figure 2h. Exposure of the implants following four months to remove the membrane. Note complete coverage of the previously exposed implant threads and anatomically optimal ridge form.

by orthodontic extrusive forces, the periodontium also migrates with the tooth. This will lead to an increase in bone height, as well as movement of the soft tissue in a coronal direction.

Clinical Case No. 3

A clinical case, utilizing this technique is illustrated in **Figures 3 and 4**. This patient presented with a vertical defect on the mesial aspect of tooth No. 8. This tooth was determined to have a hopeless prognosis and was planned to be replaced with an implant. However, the vertical defect had to be corrected to make sure that the implant will be in bone all around and the soft tissue level and papilla are restored. To facilitate this, the tooth was subjected to orthodontic extrusion, which was accomplished in approximately six months, resulting in leveling of the vertical defect. The tooth was subsequently extracted and replaced immediately with an implant and provisionalized. Four months after implant placement, final ceramometal restoration was completed by his restorative dentist.

Soft Tissue Grafting

Although the underlying bone determines to large extent the position

Figure 3a. Correction of vertical boney defect with the aid of orthodontic therapy and immediate implant placement. Radiograph illustrating severe vertical defect on mesial aspect of tooth No. 8, shortly after initiation of orthodontic therapy.

Figure 3b. Three months following initiation of orthodontic therapy.

Figure 3c. Completion of orthodontic therapy following approximately six months of extrusion. Note flattening of the vertical defect on mesial aspect of tooth No. 8.

Figure 3d. Radiograph at the time of extraction and immediate implant placement.

of the soft tissue, there may be circumstances where the overlying soft tissue may be too thin. In such cases, soft tissue augmentation may be required. Moreover, some surface deformities may be more easily correctable with soft tissue augmentation with or without bone augmentation. A clinical case with soft tissue augmentation is illustrated in another article in this issue.

Ridge Preservation

The atrophic maxilla poses a therapeutic challenge, which requires additional reconstructive procedures in order to allow for placement of stable implants. The principal reasons for the difficulty in restoring the posterior maxilla with dental implants include low bone density, narrow buccopalatal width, minimal bone height and proximity to the maxillary sinus. In situations with limited bone height in the posterior maxilla due to the proximity of the maxillary sinus, a sinus lift is performed. Sinus lift is a procedure to elevate the floor of the sinus by bone augmentation. Deficiencies in horizontal and vertical dimensions of the maxilla may be corrected with onlay bone grafting or GBR. There are two main approaches to accomplish sinus lift, namely lateral and crestal antrostomy approaches.

Lateral Antrostomy

Lateral antrostomy technique was originally described by Boyne and Tatum.[4,5] There have been numerous publications since then, with modifications of the technique and the bone graft material. This procedure entails full-thickness reflection of a flap in the posterior maxilla. The access into the maxillary sinus cavity is made by means of opening trapdoor, which is intruded medially and in a superior direction. Prior to displacing the trapdoor medially, the sinus membrane is carefully teased away from the lateral wall and reflected into the sinus cavity. Once access is gained to the sinus cavity, the space is filled with bone graft material. Autogenous bone is the material initially described by Tatum and Boyne and remains the gold standard. A variety of biomaterial, including allogenic (freeze-dried bone allograft), xenogenic (anorganic bovine bone), as well as synthetic material (hydroxyapatite and tricalcium phosphate) have also been used, either as single agents or as composite material. Moreover, autologous platelet-rich plasma has been used as a source for growth factors to enhance bone regeneration in sinus augmentation surgery.[6] There is some controversy about the outcome of implants placed in sinuses augmented with various grafting materials. In a systematic review of the literature in sinus augmentation surgery, Wallace and Froum did not find a large difference among various grafting material used.[2] Prospective randomized clinical trials testing the efficacy of different graft material will be required to definitely address this issue.

Implants are placed either simultaneously at the time of sinus lift or following a healing period. The decision to place the implants either simultaneously or delayed depends on whether primary stability of the implant can be anticipated at the time of bone grafting. Wallace and Froum in their review noted that the survival rate of implants placed in sinuses augmented with the lateral window technique varies between 62 percent and 100 percent with an average survival rate of 92 percent.[2]

Figure 4a. Immediate implant and provisional placement of tooth No. 8 treated with orthodontic extrusion. Clinical view at completion of orthodontic therapy, following approximately six months of extrusion. Note facial soft tissue level of tooth No. 8 matches contralateral tooth and the interproximal papilla is of normal dimensions.

Figure 4b. Facial view of extraction site, showing intact soft tissues.

Figure 4c. Extracted tooth No. 8, showing extensive removal of coronal structure during orthodontic therapy.

Figure 4d. Occlusal view of a 4.3 x 13 mm tapered implant with internal prosthetic connection.

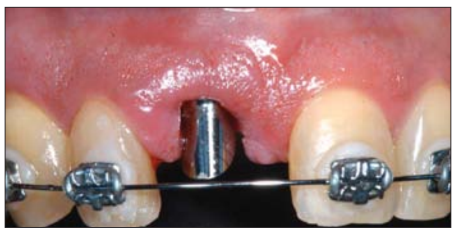


Figure 4e. Definitive abutment in situ.

Figures 4f and g. Provisional fabricated and finished extra-orally and cemented.

Figures 4g.

Figure 4h. Final ceramometal restoration completed following four months of healing.

Clinical Case No. 4

A clinical case managed with lateral antrostomy sinus augmentation is illustrated in **Figure 5**. Because this patient presented with generalized severe atrophy in the posterior maxilla with proximity of the maxillary sinus (**Figure 5a**), lateral antrostomy sinus augmentation was planned. The anatomy of the area was complicated by the presence of multiple lobes separated by septa. To that end, mucoperiosteal flap was reflected and two U-shaped trapdoors were opened to each of the sinus lobes and were intruded, displacing the sinus membrane medially and superiorly (**Figure 5b**). Three implants were placed and primary stability of the implants was achieved, though the apical two-third was not engaged in bone (**Figure 5c**). Autogenous bone cores were removed from the symphysis of the chin (**Figure 5d**) and the bone cores were processed into particulate form (**Figure 5e**). Platelet-rich plasma was extracted from patient's blood (**Figure 5f**) as a source of growth factors and mixed in with the bone to enhance the bone augmentation.

Crestal Approach Sinus Lift

The crestal approach was originally described by Summers as a less invasive alternative to the lateral antrostomy.[7] The crestal approach entails exposure of the alveolar ridge, followed by compression of bone with cylindrical instruments referred to as an osteotomes (**Figure 6**). Sequentially larger diameter osteotomes are used to displace the floor of the sinus in an apical direction. Bone graft material is then introduced into the floor of the sinus through the osteotomy site. Summers' original bone graft material was composed of autogenous bone in combination with hydroxyapatite.

Figure 5a. Lateral antrostomy sinus augmentation. Radiograph showing severe atrophy of the maxillary right posterior area and highly pneumatized maxillary sinus.

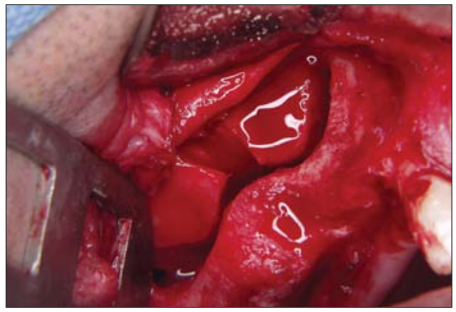


Figure 5b. The sinus exhibits multiple lobes separated by septa. Access to the sinus cavity has been establishing by making U-shaped trapdoors to each of the lobes lateral wall of the sinus, which have been intruded.

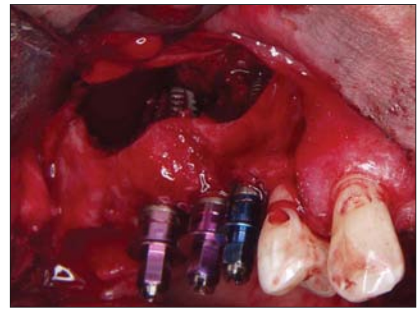
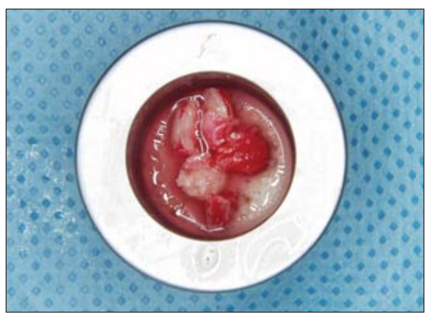


Figure 5c. The sinus membrane is displaced superiorly. The corners of the trapdoor were rounded. Placement of three implants which had primary stability, though the apical two-third was not engaged in bone.



Figures 5d-g. Autogenous bone cores were removed from the chin. These bone cores were made into particulate bone. Platelet-rich plasma was extracted from patient's blood and mixed in with the bone. The mixture of particulate autogenous bone along with PRP was packed around the implants.

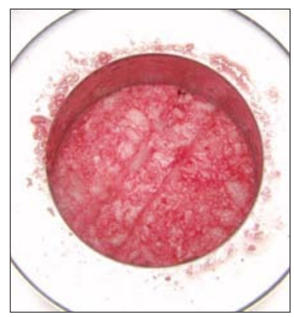


Figure 5e.

Figure 5f.

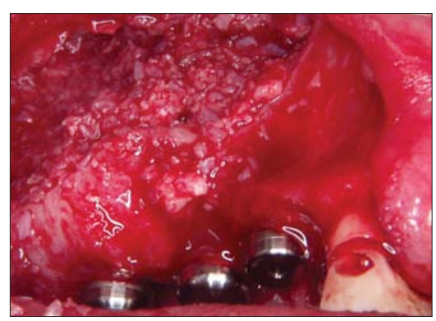


Figure 5g.

However, a variety of graft materials have also been described in the literature in conjunction with this approach.

Clinical Case No. 5

Figure 7 illustrates a clinical case managed with crestal approach sinus augmentation. This patient presented with missing maxillary first molar and a mesially inclined second molar (**Figure 7a**). Orthodontic therapy was performed to realign the dentition and establish proper space for the first molar (**Figures 7b-c**). The implant site exhibited limited vertical bone height (approximately 4 mm) requiring sinus augmentation.

Crestal approach sinus augmentation was performed by using osteotomes of increasing size to compress the alveolar bone in a lateral and apical direction (**Figure 7d**). Freeze-dried bone allograft was used for the augmentation procedure (**Figure 7e**). During the nine-month healing period, orthodontic therapy was completed. Access to the crestal bone was achieved by removing a core of soft tissue with a punch (**Figure 7f**). A 6 x 13 mm tapered implant was inserted, which had primary stability (**Figure 7g**). The implant was restored six months after placement (**Figure 7h-i**).

The crestal approach sinus lift is a technique-sensitive procedure. As with any other surgical procedure, there are potential complications. These include possibility of sinus membrane perforation, bleeding, infection, as well as vertigo and inner ear disturbances resulting from the tapping action of the osteotomes. Therefore, additional training and experience is required for successful and safe execution of this procedure.

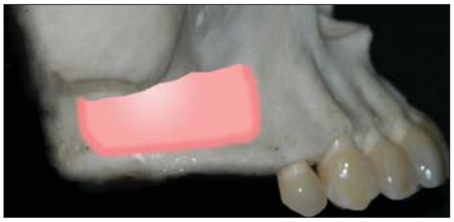


Figure 6a. Crestal approach sinus lift. Diagram depicting an edentulous maxillary posterior area with reduced alveolar bone height and proximity of maxillary sinus.

Figure 6b. Osteotomes of increasing size are used to compress the alveolar bone in a lateral and apical direction, displacing the bone, which will elevate sinus membrane.

Figure 6c. Additional bone graft material may or may not be needed, depending on original bone height to create an appropriate implant site. Implants placed with adequate bone apical to the implants.

Alveolar Distraction Osteogenesis

Alveolar distraction osteogenesis is a biologic process by which new alveolar bone is formed following a gradual separation of a block of bone from the ridge. This process can correct alveolar deformities in ridge height and width.[8,9] Alveolar distraction osteogenesis entails exposure of the ridge by a mucoperiosteal flap, sectioning (osteotomy) and mobilization of the alveolar bone and attachment of the distraction device. Following an initial rest period, the distraction device is activated, typically moving at a rate of 1 mm per day. The device must be activated in accordance with the required height of the alveolar ridge (up to 15 mm).

Clinical and radiological evaluations are carried out to monitor the regeneration process and determine when the desired height or width have been reached. The device is then removed following another rest period, which will allow consolidation of newly generated bone with native bone. Implants may then be placed in the regenerated site. Distraction osteogenesis has the advantage of inducing rapid bone regeneration of new bone without the need for a secondary donor site.

Tissue Engineering

Autologous, allogenic and alloplastic materials for oral reconstruction have some limitations, which has prompted the development of tissue engineering techniques in search of better methods. Tissue engineering techniques endeavor to produce fully formed tissues in the laboratory (in vitro), which are then implanted in the patient. This is in contrast to the regenerative techniques discussed earlier in this paper, which introduce hard or soft tissue grafts into deficient sites to regenerate the lost tissues in the patient (in vivo). Tissue engineering techniques typically entail seeding of progenitor cells on a scaffold, which mimics the tissue surrounding cells (extracellular matrix). Cells are then cultured in vitro, so that they can proliferate and produce the phenotype of the tissue they are replacing.

There are a number of enabling technologies, which have enhanced the feasibility of tissue engineering today. These include the development of matrices, which are porous, absorbable scaffolds that mimic the environment surrounding cells in the body. Another development is advancement of cell culture techniques that allow proliferation of cells in culture which retain their phenotype. The availability of genetically engineered growth factors is another very important advancement, since growth factors are essential for regulating regeneration.

Advances in tissue engineering technology have led to the application of biologic concepts in regeneration of oral hard and soft tissues. There are many examples of application of engineered tissue for oral reconstruction, which are at various stages of development.[10] Cultivated mucosa and bone grafts have been utilized in oral reconstruction.[11] A far-reaching goal pursued by some investigators is regeneration of teeth using stem cells.[12]

Growth factors

Growth factors are important regulators of tissue regeneration and many growth factors have clinical application. Growth factors have been utilized to enhance the results of in vivo regenerative techniques or used in vitro to develop engineered tissues.[13] Recombinant growth factors, such as bone morphogenetic protein-2 and osteogenic protein-1 are currently in clinical use in orthopedic surgery. Although there have been experimental utilization of these growth factors for oral reconstructive surgery, these are not yet approved for clinical use by the Food and Drug Administration.

Enthusiasm for clinical utility of growth factors is dampened by some practical problems in their application. Although some growth factors have been shown to enhance bone formation, extremely high levels are usually required, which is not possible on a sustained level. Another

Figure 7a. Clinical example of a case utilizing crestal approach sinus lift followed by implant placement. Preoperative radiograph of missing tooth No. 3 showing limited vertical bone height (approximately 4 mm) and proximity of maxillary sinus.

Figures 7b and c. Patient underwent orthodontic therapy, which included up-righting mesially inclined second molar.

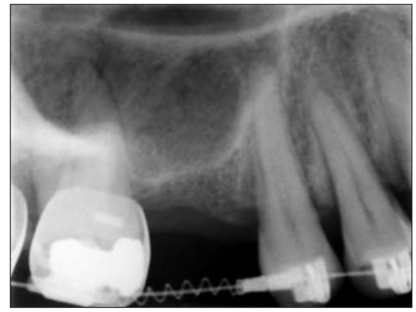


Figure 7b.

Figure 7d. Osteotomes of increasing size were used to compress the alveolar bone in a lateral and apical direction.

Figure 7e. Freeze-dried bone allograft was used for the augmentation procedure.

Figure 7f. Following a nine-month healing period, a core of soft tissue was removed to gain access to the crestal bone for minimally invasive implant placement.

Figure 7g. A 6.0 x 13 mm tapered implant was placed.

Figure 7h. The implant was restored six months after placement.

Figure 7i. Radiograph of the restored implant six months following loading.

problem is the considerable expense of the process. A more recent development has been the application of gene therapy to provide sustained release of these growth factors in the local environment.[14]

Gene Therapy

Gene therapy is a therapeutic modality involving transfer of a specific DNA fragment to target cells. The application of this technology to bone regeneration is to induce a sustained release of growth factors necessary for bone regeneration.[15] The DNA may either be introduced into cells directly in the patient (in vivo gene therapy), or the DNA may be inserted into target cells outside the patient first (ex vivo gene therapy), followed by

Figure 8a. Illustration of Alveolar distraction osteogenesis. Diagram depicting severe atrophy of the mandibular anterior area.

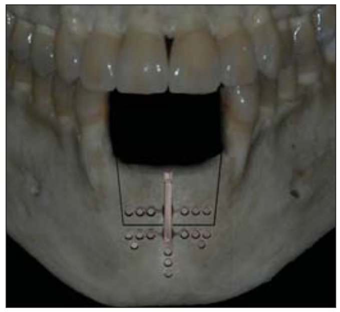


Figure 8b. Although adequate bone remains for placement and stability of implants, because of the severe ridge atrophy, the prosthetic outcome will be esthetically undesirable. Very long clinical crowns have to be constructed to span the increased inter-occlusal distance. Diagrammatic illustration of an alveolar distraction device attached following sectioning a trapezoid-shaped segment of the ridge to be distracted.

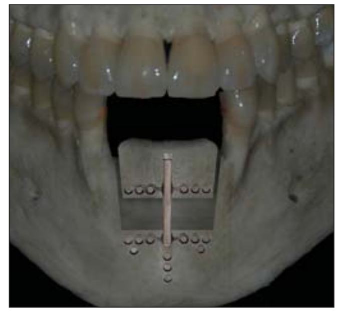


Figure 8c. Upon activation of the device, the sectioned segment is gradually displaced coronally to a desired position. Bone will eventually fill in the area between the displaced segment and the ridge so that vertical height of the ridge is increased. Following a healing period, the device is removed and implants are placed in that site.

transfer of cells carrying the DNA into the patient. DNA can be inserted into cells by the aid of viruses or by other non-viral means such as liposomes (lipid spheres). A variety of viruses have been used to transmit DNA sequences into target cells, including retroviruses, adenoviruses and adeno-associated viruses. These viral vectors have been rendered incapable of replication by genetic manipulation to insure safety of the host. Gene therapy for the purpose of tissue regeneration has been studied in laboratory animals and is a promising technology.[16] There are a number of technical, as well as ethical issues related to this technique that have to be worked out prior to its application in human.

Conclusions

Optimal restoration of dental implants often requires reconstruction of bone and soft tissues. Today, a variety of approaches have been described to achieve predictable reconstruction of bone and soft tissues. The future of oral reconstruction will no doubt involve application of biological principles, involving growth factors and utilization of bioengineered tissues. CDA

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Minimally Invasive Surgery: An Alternative Approach for Periodontal and Implant Reconstruction

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ABSTRACT

Minimally invasive surgery is defined as a procedure involving a smaller access opening and less-extensive surgical manipulation of the tissues that surround the target structure. It represents a rapidly advancing and expanding therapeutic modality in medicine and dentistry. Minimally invasive surgery has been touted as one of the major advances in medicine of the past two to three decades. The revolution in this field has been made possible by technological advances in imaging, instrumentation, and robotics. These advances have been driven in part by patient demand.

Today's patients lead a busy and active lifestyle, and prolonged periods of convalescence are not acceptable for many. Therefore, the advent of minimally invasive surgery has promoted increased patient acceptance, which result from decreased morbidity associated with the minimally invasive surgery approaches.

As technology and expertise improve, more advanced minimally invasive surgical procedures are being successfully performed. A multitude of surgical alternatives have been introduced, using minimally invasive approach. Minimally invasive surgical approaches are now routinely used for many operations in the abdominal cavity (laparoscopy), thorax (thoracoscopy) and joint spaces (arthroscopy). Novel applications are continually being developed, such as blood vessel harvest for coronary artery bypass, spinal surgery and neurosurgery. Minimally invasive techniques have even become the gold standard in some surgical disciplines. A classic example is

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in general surgery, where laparoscopic removal of the gall bladder (cholecystectomy) has supplanted traditional open cholecystectomy as the primary operative treatment. One of the exciting technological advancements is the introduction of robots for performance of surgery. Robotic-assisted surgery is performed with robotic arms controlled by the surgeon through a small incision or no incision except for the instruments and camera portholes. Minimally invasive techniques have been developed to minimize surgical trauma and improve cosmetic results compared to the conventional full access surgery. It is estimated that approximately one-fourth of the 15 million surgeries performed each year are performed using minimally invasive surgery and robots are believed to raise that number substantially.[1] Currently, robotic technology is used for thoracic, abdominal, pelvic, and neurological surgical procedures. Minimally invasive surgery reduces the amount of inpatient hospital days and the computer in the system filters any hand tremors a surgeon may have during the surgery.

Minimally Invasive Approaches in Dentistry

In recent years there have been a number of technological advances in equipment and dental material, which have lead to an expansion of minimally invasive approaches in dentistry. Specifically, advances in adhesive dentistry have made it possible to preserve more tooth structure by utilizing bonded restorations.

Minimally Invasive Approaches in Periodontal and Implant Reconstruction

Many of the periodontal and implant reconstructive procedures can be performed using a minimally invasive approach. Minimally invasive surgery requires:

A) Dedication to gentle manipulation of tissues surrounding the therapeutic target,

B) Utilization of specialized instruments and material to allow working through a small access,

C) Exploitation of imaging technology, such as three-dimensional CT scan, tomography, etc. to obviate the need for direct visual access through surgical flap and,

Currently, robotic technology is used for thoracic, abdominal, pelvic, and neurological surgical procedures.

D) Magnification through the surgical microscope, when appropriate to assist with performance of the procedure through a smaller access.

The following areas describe some of the applications of minimally invasive surgery in intraoral surgery.

Soft Tissue Grafting

An array of mucogingival procedures have been described for treatment of gingival recession and coverage of denuded roots. These include free gingival graft, connective tissue graft, laterally positioned flap, coronally positioned flap, as well as guided tissue regeneration.[2-5]

Recently, tunnel preparation has been proposed as an alternative technique to the open flap for preparation of the recipient site.[6] Tunnel preparation entails working through a small access and preparing a space under the mucosa without reflection of a flap. For root coverage of teeth with gingival recession, tunnel preparation is started at the gingival sulcus creating a space under the mucosa, extending beyond the mucogingival junction. This would allow insertion of a soft tissue graft under the gingival collar. Tunnel preparation avoids reflection of papillae, thereby maintains the integrity of the blood supply to the flap. A variety of donor tissues that have been utilized in an attempt to reduce the surgical trauma required for harvesting donor tissue. Acellular dermal matrix allograft is an alternative to autogenous donor material. The advantages of utilizing allograft material is the elimination of the need for harvesting donor tissue from an intraoral site.

In comparing acellular dermal matrix to palatal connective tissue graft for treatment of gingival recession, it has been demonstrated that connective tissue graft results in significantly greater gain of keratinized gingival.[7] However, no practical differences between the two therapeutic modalities were demonstrated with respect to root coverage. Similar results have also been demonstrated by Woodyard et al., who found significantly increased gingival thickness and coverage of recession defects with acellular dermal matrix.[8] Harriso et al. recently reported that the degree of root coverage achieved by acellular dermal matrix and connective tissue graft were comparable in the short-term.[9] However, the connective tissue graft held up with time better than acellular dermal matrix. These investigators noted that the results were not universally applicable, since one-third of the cases treated with acellular dermal matrix improved or remained stable with time. Therefore, in selecting the appropriate source of tissue for achieving root coverage, the options need to be weighed with the patient. Connective tissue grafts are generally utilized when areas of recession are localized or when there is a critical need for maintenance of stable gingival margins, e.g. near restoration margins in the esthetic zone.

In such areas relapse of the recession will create an esthetically unacceptable situation. On the other hand, in areas of generalized recession, where the areas of recession to be corrected are greater than the source of tissue on the palate, allograft material offer a viable alternative.

Clinical Case No. 1

In the clinical case illustrated in **Figure 1**, multiple areas of recession were noted in the premolar areas, as well as the mandibular incisor area. The etiology of the gingival recession may be multifactorial, including contributory factors such as occlusal forces, as well as aggressive tooth brushing. The treatment plan included augmentation of the zone of attached gingiva and root coverage. Because of the generalized nature of gingival recession, acellular dermal matrix allograft was selected as a soft tissue graft material. **Figure 1b** shows the recession of teeth Nos. 19, 20 and 21, ranging from 2 mm to 4 mm. Following scaling and root planing, a tunnel preparation was used as access to insert the allograft under the overlying mucosa (**Figure 1c**).

Coronal positioning of the gingiva was performed (**Figure 1d**) and the position of the gingiva was stabilized, using composite material (**Figure 1e**). The function of composite is to prevent micro-movement of the tissue, which will prevent retraction of the gingival margin. Postoperative results show complete coverage of the denuded roots, along with establishment of a zone of attached mucosa (**Figure 1f**).

Implant Placement

Implant techniques have evolved a great deal since the initial introduction of endosseous implants to clinical practice. Implants were originally developed for treatment of fully edentulous patients. In recent years the indications for implants have expanded to include partially edentulous dentition, as well as for replacement of single teeth. The original Brånemark protocol for dental implant treatment was based on submerged healing prior to loading. However, immediate loading has been reported possible with high success rates for various indications, provided that good bone quality and quantity are present (see review by George Romanos, DDS, DMD, PhD, on page 993.)

In this scheme, three-dimensional sensors attached to the drill and the jaw will track the relative position of the drill to the jaw.

The protocol for placement of dental implants has also been significantly modified. The initial protocol entailed full thickness flap reflection, placement of implants, which were submerged under the flap for approximately six months. This was followed by a second phase surgery to uncover implants. During this surgery, the cover screw was replaced with a healing abutment, allowing transmucosal extension of implant components. After approximately four to six weeks of healing, the healing abutment was to be replaced with definitive abutment and restoration.

Although this protocol has proven very predictable, it requires a number of surgical procedures. There have been a number of modifications to this protocol, reducing the number of required procedures. One modification has been single-stage placement of implants, whereby the implants are transmucosally placed. This revised protocol has the advantage of eliminating the need for a second phase surgery. There are a number of studies, which have demonstrated that the success rate of single stage implant placement is equivalent to that of two-stage procedure. A further modification of the original protocol has been minimally invasive placement of implants, often referred to as the "flapless implant placement." There is limited documentation of the success rate of flapless placement of implants.[10-13] As described below, the term "minimally invasive implant placement" is preferred over "flapless implant placement," since in many occasions tunnel preparation may be required for exploration or augmentation of the implant site.

A recent development has been computer-assisted implant placement.[14] There are several different methods currently available for computer-assisted implant placement. In the most common protocol, 3-D imaging data obtained by computerized tomographic scan are transferred to a planning software to determine optimal implant placement criteria, such as implant position, width, length and angulation. The data in planning software are then used to fabricate a precise surgical guide by rapid prototyping, also referred to as stereolithography. A more advanced application of comput-

Figure 1a. Treatment of gingival recession by root coverage. Preoperative view.

Figure 1b. Preoperative view of the mandibular left posterior area, showing gingival recession and the presence of a minimal zone of attached gingival.

Figure 1c. Tunnel preparation has been made and a 1 x 2 cm acellular dermal matrix allograft was inserted into the space created by the tunnel preparation.

Figure 1d. Polypropylene sutures were used to stabilize the soft tissue graft material and ligate the opening of the tunnel.

Figure 1e. Coronal positioning of the overlying mucosa was accomplished and the tissue was secured by means of composite to tooth No. 20.

Figure 1f. Postoperative view, showing complete root coverage, as well as establishment of a zone of bound-down mucosa.

er-assisted implant placement is intraoperative navigation. In this scheme, 3-D sensors attached to the drill and the jaw will track the relative position of the drill to the jaw. In the intra-operative navigation system, it will be possible to provide the surgeon with real-time feedback to assist in executing the pre-planned implant position.

Implant Site Development

Placement of implants in a prosthetically desired location often requires augmentation of the implant site, either prior or simultaneously with implant surgery. The augmentation procedures, collectively referred to as "implant site development," include procedures such as onlay bone block grafting, soft tissue augmentation, sinus lift, etc. In a separate article in this issue, these procedures have been reviewed. A few of the minimally invasive procedures for implant site development will be discussed here in the context of clinical cases to illustrate their application.

Crestal Approach Sinus Lift

The crestal approach is a minimally invasive alternative to the lateral approach sinus lift. This procedure entails utilization of osteotomes, which are cylindrical instruments used to move the floor of the sinus in an apical direction, along with bone graft material inserted into the sinus.

This procedure utilizes bone graft material, which are inserted into the sinus with the aid of osteotomes to displace the sinus membrane in an apical direction, thus increasing the vertical height of bone to stabilize implants. The decision to place the implants simultaneously or after sinus lift depends on whether or not primary stability of the implants can be achieved with the existing bone at the time of augmentation. Although crestal approach sinus lift is significantly less invasive than lateral wall sinus lift, this procedure is very technically challenging. Additional training is required for successful execution of this procedure.

Clinical Case No. 2

The clinical case in **Figure 2** illustrates minimally invasive implant placement. This 65-year-old male presented with missing posterior teeth, with the exception of right premolars, which exhibited advanced attachment loss and mobility (**Figures 2a-d**). His medical history was significant for past history of myocardial infarction approximately 25 years ago with subsequent triple bypass surgery. He was on anticoagulant therapy. CT imaging was performed to ensure the adequacy of the edentulous ridge and plan implant size, position and angulation (**Figure 2e**). Teeth Nos. 4 and 5 had been extracted subsequent to the CT imaging. The vertical height of bone in some of the proposed implant sites was inadequate, necessitating simulataneous sinus elevation. Access to crestal alveolar bone was obtained by soft tissue punch (**Figure 2f-g**), osteotomy preparations were made and trial posts were inserted (**Figure 2h**) to examine suit-

Figures 2a-d. Minimally invasive implant placement. Preoperative clinical views of a 65-year-old patient, illustrating lack of posterior occlusion and severe attrition of anterior teeth.

Figure 2b.

Figure 2c.

Figure 2d.

Figure 2e. CT scan images showed adequate bone volume and favorable topography for minimally invasive implant placement.

Figures 2f-h Access to crestal bone was obtained by soft tissue punch, osteotomy preparations were made and trial posts were inserted to examine suitability of implant position.

Figure 2g.

Figure 2h.

Figure 2i. Teeth Nos. 12 and 13 were extracted and implants were immediately placed in extraction sites.

ability of implant position relative to adjacent and opposing teeth and implant sites. Teeth Nos. 12 and 13 were extracted and anatomically contoured implants were immediately placed in their extraction sites (**Figure 2i**). The 3-D geometry of these implants approximates that of extracted roots. Internal mattress sutures were placed at the extraction sites to achieve primary closure of the marginal gingiva around newly placed implants. Mandibular right posterior implants were similarly placed with implants placed immediately in extraction sites of teeth Nos. 21, 28 and 29 (**Figure 2j**). Because of the critical positioning of implants in the mandibular left posterior area relative to the width of the alveolar ridge, as well as proximity of the mental foramen, a small crestal incision was made in that area and localized mucoperiosteal reflection was made (**Figure 2j**). Patient reported relatively comfortable

Figure 2j. This shows view of the maxillary left posterior area at the time of implant placement and one-week postoperative healing of the maxillary right posterior area. Mandibular posterior implants were similarly placed with implants inserted in extraction sites of teeth Nos. 21, 28 and 29.

Figure 2k. Provisional restoration was fabricated and delivered within one week of implant placement.

Figures 2l-q Approximately six months following placement of implants, final ceramometal restorations were delivered.

Figure 2m.

Figure 2n.

Figure 2o.

Figure 2p.

Figure 2q.

Figure 2r. Panoramic radiograph taken 18 months following implant placement illustrating stability of bone around implants.

postoperative experience, which is typical of patients undergoing minimally invasive implant placement. Provisional restorations were fabricated and delivered within one week of implant placement (**Figure 2k**). Approximately six months following placement of implants, final ceramometal restorations were delivered (**Figures 2l-q**). Panoramic radiograph taken 18 months following implant placement (**Figure 2r**) illustrates stability of crestal bone around implants. Possible explanation for the stability of bone and soft tissue around implants placed using a minimally invasive approach is avoidance of mucoperiosteal reflection, which is known to be associated with crestal bone loss.

Since the success rate of conventional implant therapy technique has been thoroughly demonstrated through the years, the same scrutiny will be required of minimally invasive implant placement. There is currently a paucity of reports documenting the success of minimally invasive implant placement.[15] In a retrospective analysis of 1,000 consecutively placed implants, the survival rate of implants placed by means of minimally invasive access were compare with that of convention protocol utilizing mucoperiosteal flap access. The follow-up period for this study ranged from 12 to 60 months. In this analysis, it was found that the overall survival rate of implants placed using the minimally invasive protocol (94.9 percent), compared favorably with that utilizing a mucoperiosteal flap access (96.6 percent). Therefore, further studies documenting safety and efficacy of minimally invasive implant placement, in particular prospective randomized clinical trials is merited.

Microsurgery

The surgical microscope can provide magnification, which can be beneficial in performing certain procedures. There have been some clinical reports to describe some of the advantages of microsurgery, including improved ability to achieve primary closure, better tissue preservation, improved visualization of tooth structure to remove calculus and accelerated wound healing.

One of the novel applications of microsurgery is in the sinus lift procedure. The surgical microscope can aid in visualization of the sinus membrane

Figure 3a. Radiograph of a fractured tooth No. 13.

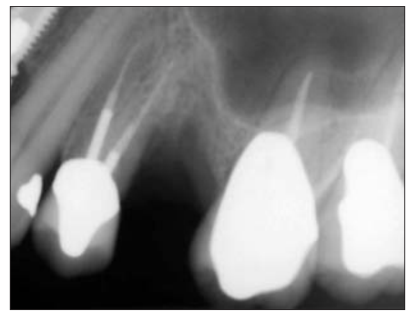


Figure 3b. Extraction of tooth No. 13 led to a substantial defect with reduced vertical height of alveolar bone and proximity of the maxillary sinus.

Figures 3c-e. A crestal access was introduced using a 4 mm soft tissue punch, exposing the alveolar crest.

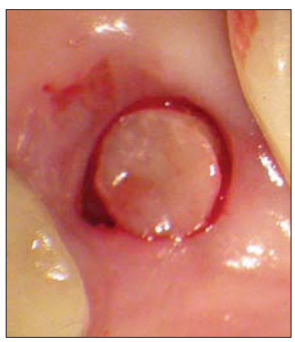


Figure 3d.

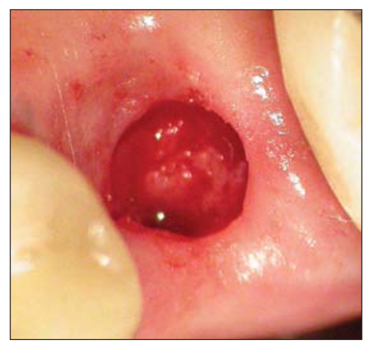


Figure 3e.

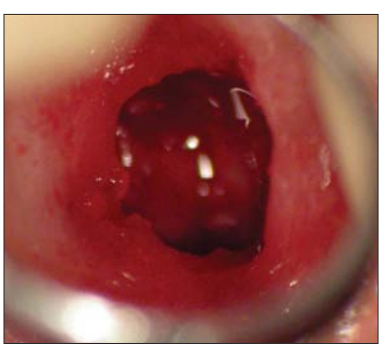
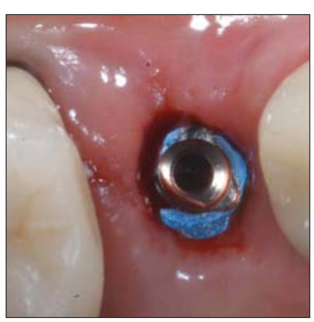


Figure 3f. Osteotomy preparation of the implant site was performed, which exposed the sinus membrane.



Figures 3g and h. Anorganic bovine bone graft was used to displace the sinus membrane in an apical direction and insert the implant.

Figure 3h.

to allow elevation of the membrane in an intact manner.

Clinical Case No. 3

The clinical case in **Figure 3** shows a patient who presented with fractured tooth No. 13 (**Figure 3a**). Extraction of tooth No. 13 led to a substantial defect with reduced vertical height of alveolar bone and proximity of the maxillary sinus (F**igure 3b**). A crestal access was introduced using a 4 mm soft tissue punch (**Figures 3c-d**), exposing the alveolar crest (**Figure 3e**).

Osteotomy preparation of the implant site was performed, which exposed the sinus membrane (**Figure 3f**). Anorganic bovine bone graft was used to displace the sinus membrane in an apical direction and insert the implant (**Figure 3g**). Thus, magnification achieved by the surgical microscope is instrumental in implant site development and placement.

Soft Tissue Augmentation

To achieve optimal results when implants are placed in the esthetic zone, soft tissue augmentation is often required. Soft tissues esthetics is one of the most important aspect of achieving natural esthetics of restorations.

Clinical Case No. 4

The clinical case illustrated in Figure 4, shows a missing tooth No. 10 (**Figures 4a-b**) with horizontal ridge atrophy (**Figure 4c**). Soft tissue punch was used to gain access to crestal bone in the planned implant site (**Figure 4d**). This was followed by osteotomy preparation and placement of a 3.5 x 13 mm implant (**Figure 4e**). The current implant placement guideline dictates placement of implants slightly on the palatal aspect of the ridge in an effort to avoid impinging on the facial boney wall, which may cause dehiscence. Therefore, the implant body will not support the facial soft tissue and additional soft tissue grafting was performed. To that end, soft tissue was harvested from the tuberosity area (**Figure 4f**). This tissue typically is highly fibrous in consistency and exhibits relatively low shrinkage over time. A tunnel access was made on the facial aspect through the original soft tissue punch. The soft tissue graft was inserted through the small access opening (**Figure 4g**). The implant was restored following a four-month healing period and a one-year follow-up visit. The soft tissues around the implant-supported restoration mimicked those of adjacent teeth (**Figures 4h-j**). The soft tissue prominence apical to the restoration, resembles the prominence created by roots of adjacent teeth.

Conclusion

Minimally invasive surgery represents alternative approaches developed to allow less extensive manipulation of

Figures 4a-c. Replacement of a maxillary lateral incisor. Clinical view showing missing tooth No. 10 with horizontal ridge atrophy.

Figure 4b.

Figure 4c.

Figures 4d-e. Soft tissue punch was used to gain access to bone in the implant site and osteotomy preparation was performed and a 3.5 x 13 mm implant was inserted.

Figure 4e.

Figure 4f. Soft tissue was harvested from the tuberosity area. A tunnel preparation was dissected through the original soft tissue punch.

Figure 4g. The soft graft was inserted through the 4 mm access opening.

Figure 4h and i. The implant was restored following a four-month healing period and at one-year follow-up visit, the soft tissues around the implant-supported restoration mimic those of adjacent teeth.

Figure 4i.

Figure 4j.

surrounding tissues than conventional procedures, while accomplishing the same objectives. A number of periodontal and implant reconstructive procedures can be performed using minimally invasive approaches. In view of the numerous benefits of minimally invasive approaches, further investigations are required to develop additional novel alternatives.

This would require development of the techniques, as well as enabling technologies to facilitate their execution. Once developed, these procedures should be evaluated by long-term follow up to prove the safety and efficacy of these approaches. Ideally, minimally invasive procedures should accomplish the same goals and objectives as their conventional counterparts. Thus, although minimally invasive surgeries are aimed at reducing the morbidity associated with open surgical approaches, they should not hinder the clinician's ability to perform a successful therapy.

As with any new procedure, additional training will be required prior to incorporating minimally invasive surgical procedures into routine clinical practice. CDA

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Robert E. Horseman, DDS

Save the Mice!

> Disney's 4-foot simulation with its annoying voice and ill-fitting shoes has been no help at all.

First of all, let me state that I am not now, nor have I ever been, a member of People for the Ethical Treatment of Animals although I subscribe wholeheartedly to its goals.

I believe animals, if left to their own volition, would rarely race around a track just for the fun of it even if they thought the rabbit was not bogus. I think they barely tolerate anyone straddling their spines whether it be jockey, cowpoke or lady in over-stuffed dressage gear. Jumping through flaming hoops would be met with lofty disregard as would be pulling heavy plows, or wearing ludicrous outfits and jeweled collars.

So I'm with PETA on these issues, but opt out when zealous members charge into a ring to terminate a staged dog fight, cock fight, or chain themselves to an elephant to protest abuse from its mahout.

I do suffer guilt pangs, especially since my own record of animal abuse is tarred with such incidents as putting my granddaughter's prized gecko out in the patio for some fresh air only to have it succumb to heat stroke during the four hours I was sorting out the Sunday newspaper. I was also particularly unresponsive with a thoroughbred Burmese cat afflicted with cataclysmic halitosis. These incidents have weighed heavily upon me until recently when I saw a chance to seek absolution for my lack of compassion.

In a belated attempt to make up for the fact I once fed baby mice to a corn snake to facilitate the passage of one of my progeny through high school biology with at least a C, I have taken up the cudgels on behalf of mice everywhere. Mice have no union, no legal representation, no bumper stickers advocating their salvation and no constitutional rights to life, liberty and the pursuit of cheddar. Disney's 4-foot simulation with its annoying voice and ill-fitting

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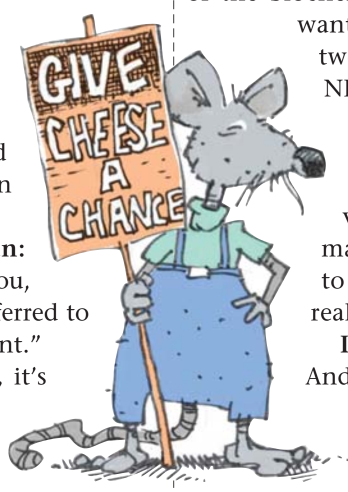
Continued from Page 1064

shoes has been no help at all.

What mice do have are scientists. It doesn't take much imagination to visualize a morning roster at a typical laboratory.

Senior Mouse: "Gentlemen, and ladies, since this is an equal opportunity extinction program, all those in Group A, the Alzheimer Program, please form an orderly line and proceed to Elan Pharmaceuticals in Dublin, Calif. Those in Group B, the Tooth-Buds-in-the-Kidney Program, count off by twos and check in at Guys Hospital in London."



Group B Spokesman: "If it's all the same to you, we would like to be transferred to the Exercise Pill Experiment."

Senior Mouse: "Sorry, it's full up. I might be able to get your people into the Recreational Whack-a-Mouse Program, however."

Group B Spokesman: "Uh … we'll get back to you on that."

Senior Mouse: "OK, then. All the Propulis Anti-decay Group C personnel queue up for the bus to the University of Rochester. Group D, you are expected with your Adidas gear for the Exercise Pill Program at the University of Texas Southwestern Medical Center. Be certain you have your waiver of liability form with you. You people in Group E, stop climbing the walls over there and proceed to Rutgers University. Check in with Dr. Allen Conney for another round of caffeine injections."

Leftover Mouse: "What about us?"

Senior Mouse: "Because you remaining mice have exhibited the highest IQs and have recorded the fastest time in the maze, you have been chosen to participate in the newest program. You …"

Leftover Mouse, interrupting: "May we inquire as to the nature of this uh, opportunity?"

Senior Mouse: "Certainly. It also will take place at the University of Texas. Dr. Steven McKnight, chairman of the biochemistry department there wants to genetically engineer two of your genes, namely NPAS1 and NPAS2, to see if he can cause you to become psychotic. If he is successful in driving you nutzoid, he may be able to figure a way to treat schizophrenia in real people."

Leftover Mouse: "I see. And what's in it for us?"

Senior Mouse: "You get a warm bed and 4 grams of Cheez-Whiz daily. Also a nice write-up in the *New England Journal of Medicine*. Maybe a note of sympathy to your folks thanking them for your sacrifice in the name of science."

Leftover Mouse: "Sacrifice?"

Senior Mouse: "I meant contribution."

And off they go, noses twitching, little rodent hearts beating a bongo rhythm. Meanwhile, the PETA bunch is off throwing red paint on fur stoles and wringing their hands over conditions at puppy mills.

Wake up you animal lovers, lest someday we arise to find the wee cowerin' timorous beasties are an endangered species, a shock comparable to discovering there is not a single mattress sale in progress anywhere. CDA