Volume 1, No. 9 December/January 2010

JIACD

The Journal of Implant & Advanced Clinical Dentistry

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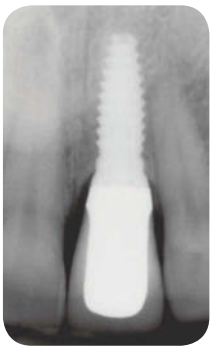

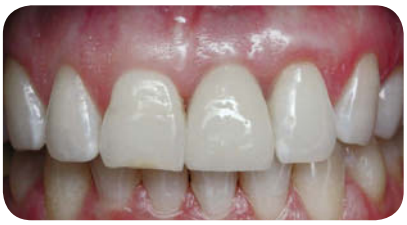

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Case courtesy of Cary A. Shapoff, DDS (Surgical); Jeffrey A. Babushkin, DDS (Restorative)

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†Clinical References available. ‡Human Histologic Evidence of a Connective Tissue Attachment to a Dental Implant. M Nevins, ML Nevins, M Camelo, JL Boyesen, DM Kim. The International Journal of Periodontics & Restorative Dentistry. Vol. 28, No. 2, 2008.

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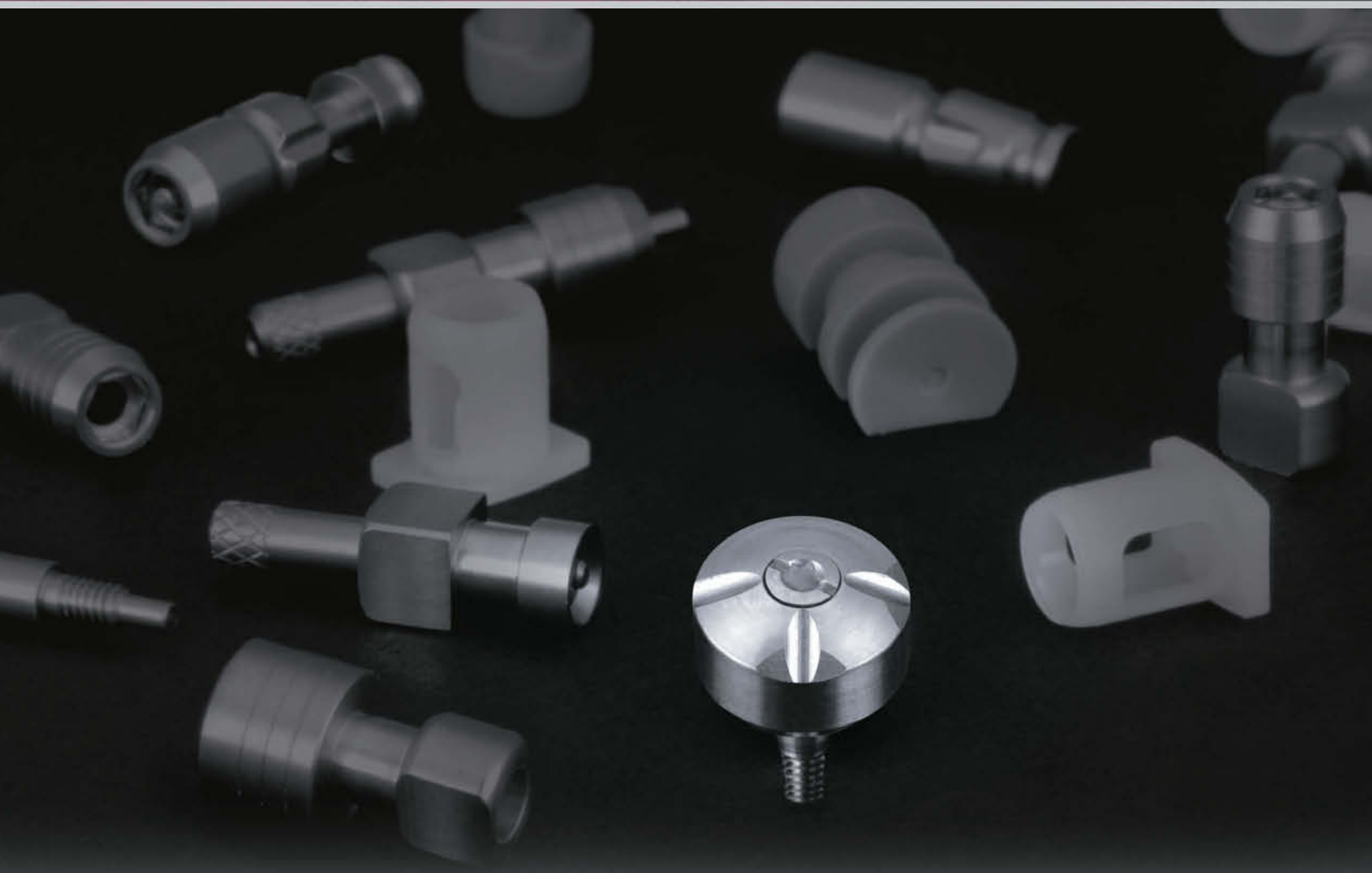

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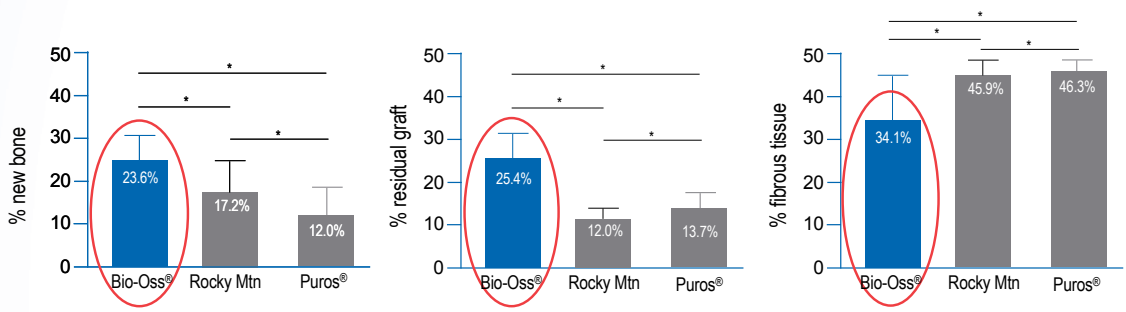

Histograms showing the percentages of (left) new bone, (middle), residual graft particles, and (right) fibrous connective tissue in the biopsy specimens. *Significant difference ($P < .05$) T = 4.5 months; n = 20

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References: [1]Lee DW, Pi SH, Lee SK, Kim EC. Comparative Histomorphometric Analysis of Extraction Sockets Healing Implanted with Bovine Xenografts, Irradiated Cancellous Allografts, and Solvent-Dehydrated Allografts in Humans. Int J Oral Maxillofac Implants 2009; 24: 609-615.

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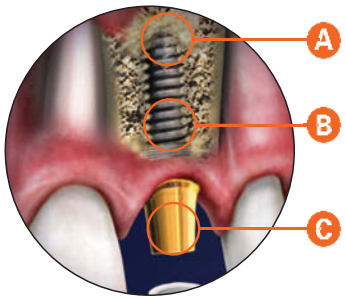

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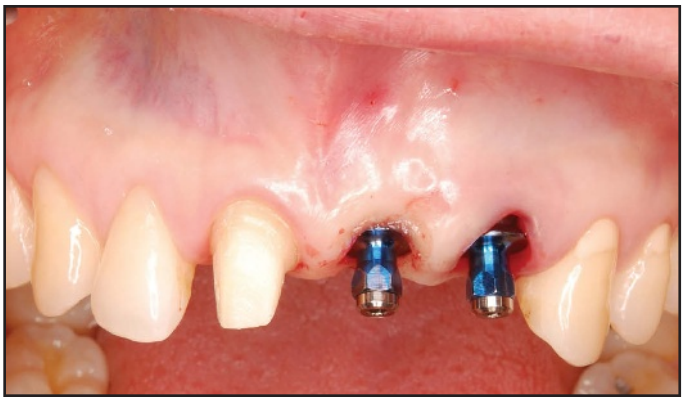

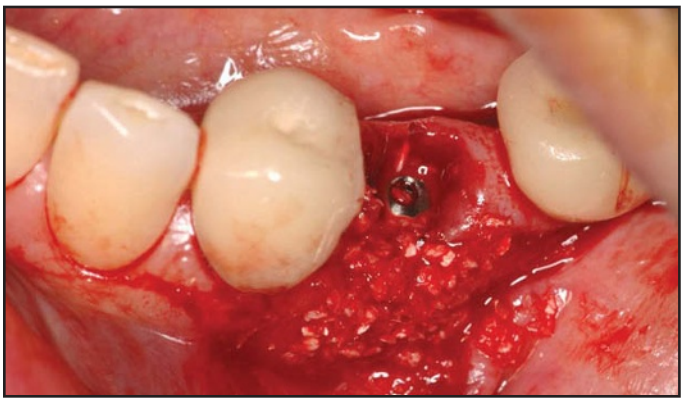

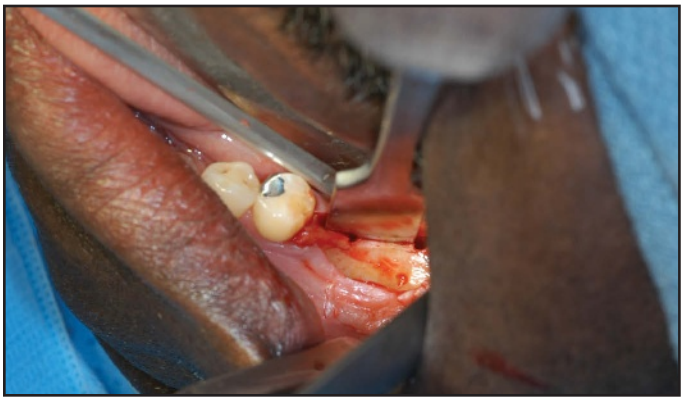

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*** Abutment (A), Abutment Analog (B), Impression Transfer (C).**

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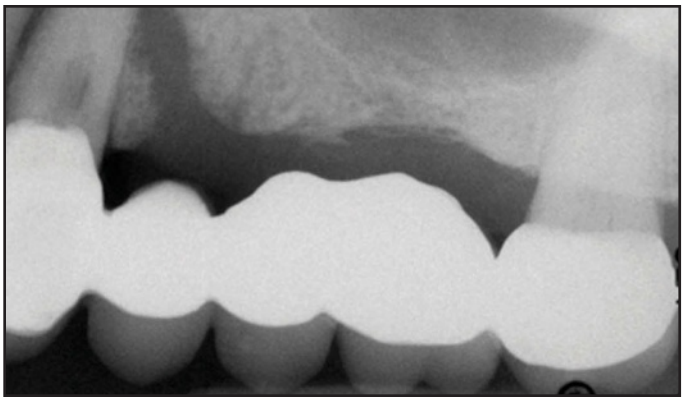

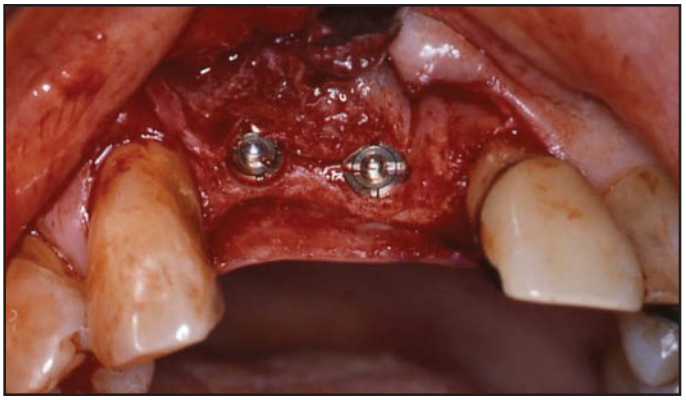

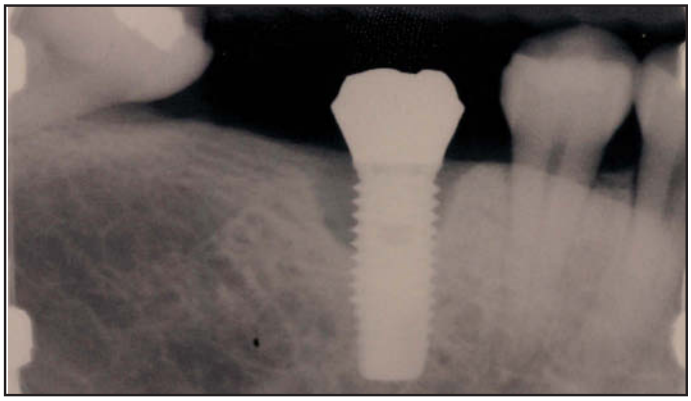

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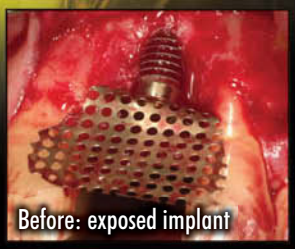
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Osteocel bone graft in place prior to mesh fixation


4 months: After mesh removal

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[1] Histologic Evaluation of a Stem Cell Based Sinus Augmentation Procedure: A Case Series. – McAllister, Haghighat, Gonshor. – Journal of Perio., April 2009

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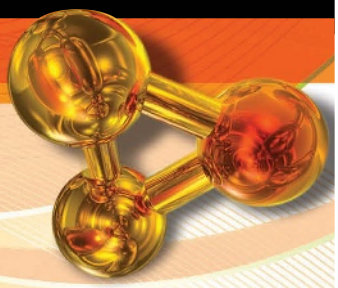

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Year One

As we draw closer to the end of the year 2009, JIACD has many reasons to give thanks. First and foremost, Nick and I would like to thank YOU for reading JIACD. Without you, there would be no need for JIACD. We do our best to turn out a product that meets the wants and desires of real life clinicians. Judging the response that we have received from our readers so far, we think that we are meeting this goal.

Did you know that since JIACD was launched in March of 2009, we have had an astounding *2.8 million* page views of the journal? Did you know that JIACD is read in 104 countries? Every month, when we review the journal's readership statistics, Nick and I are quite amazed to see that JIACD is read in nearly every country on the planet. That is really quite amazing, especially when you consider that JIACD has been in existence for less than one year.

Our explosive growth is attributed to many factors. Obviously, the internet is key reason why JIACD has been able to grow so quickly and attain a worldwide reach. With the internet, anyone with a computer has free and instant access to JIACD. This leads us to reason number two for our explosive growth: FREE and INSTANT. When you want to know something, you want the information NOW and you want it for free. JIACD gives this to you. All issues of JIACD are always available on our website www.JIACD.com 24 hours per day, 7 days per week, 365 days per year. If you want to read a JIACD article to enhance your knowledge of dentistry, you simply visit the JIACD website and get what you need. There is no ordering anything, there is no paying for anything, and there is no waiting for a copy of the article to arrive by ancient land based mail. When you want it, you get it and you get it now!

In addition to reasons one and two, we also like to think that JIACD has attracted many readers based on the quality of its content. JIACD has published many high quality articles from some of the most respected names in dentistry. We have been the first to publish many cutting edge procedures and show cases that highlight the future of implant and advanced clinical dentistry.

We are very proud of the fact that JIACD has gained a reputation as one of the most user friendly journals for article publication. For example, many authors to whom English is a second language have an extremely difficult time getting their articles published in English based journals. While the underlying content of these authors' articles are very good, communication barriers often lead to the rejection of their publication. In many cases, JIACD has assisted such authors with retooling their article for publication in an English based journal. With other journals, this task is left to the author alone and this is the reason why many of these great articles never make it to publication. JIACD does not believe in this model of placing all burdens on the author. If there is good information to be passed along to our colleagues in implant and advanced clinical dentistry, JIACD pledges to always assist the author in making this knowledge available to all. Just ask anyone who has published with JIACD about their experience. Undoubtedly, the responses will be positive and that makes us extremely proud. If you have not published with JIACD, we strongly encourage you to do so. Everyone has something to contribute.

With the second decade of the new millennium approaching, JIACD anticipates many more great things to come. We have a number of new interactive features planned for the journal which will ultimately benefit all in clinical practice. We thank you for your support and look forward to providing you with many more issues that will benefit you and your patients.

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A Windy Day

At the most recent Academy of Periodontology meeting in Boston, I was fortunate enough to discover five new miracle implants, three life changing bone graft materials and two heaven sent soft tissue allografts.

Everywhere I turned I was offered a chance to use the newest, best, cheapest and easiest implant or grafting material. However, as I stopped and spoke with each representative, the miraculous became mundane.

I asked questions which should be basic inquiries from anybody considering utilization of implants or grafting materials in patients' mouths. In considering an implant, I asked the following:

- What is the implant surface, and how is it prepared?
- What type of histologic data is available documenting the implant's success?
- What independent clinical data has been published, or accepted for publication?
- What are the prosthetic protocols for the implant?
- How do the soft tissues react around the implant following abutment connection and implant restoration?
- What data is available demonstrating the stability of implants restored by these protocols?
- Why should I consider utilization of this implant instead of the implant systems I am currently employing?

Consideration of a grafting material necessitated obtaining the answers to the following questions:

- Where is the material from?
- How is the material procured, processed and sterilized?
- Does the graft material have any proven osteoinductive capabilities?
- What is the fate of the graft material after implantation?
- What histologic data is available to assess the efficacy and fate of the graft?
- Why should I use this graft material instead of the material I am currently employing?

In short, as Don Corleone said to Salazzo: "What did I do to deserve such generosity?"

Unfortunately, the vast majority of these discussions ended in vague, unsatisfactory responses. Occasionally, statements were actually made which proved misleading at best, and untrue at worst, when further explored.

We are all fortunate enough to practice in a time when proven, predictable implants and regenerative materials abound. While clinicians may have disagreements over which implant system or grafting material to utilize, these disagreements should be grounded in published data and demonstrated success, rather than ad campaigns, pricing or friendships. While practitioners may opt to utilize different implants or graft materials which have demonstrated published proven success, such choices are understandable and wholly acceptable.

It is unacceptable to place implants or graft materials in our patients' mouths because we

have been swayed by advertiser claims, or are able to obtain these materials at a lesser price than proven alternatives.

It is also important to assess "proof" when it is presented to us. Company sponsored and directed studies, or papers published by "clinical consultants" who are paid significant fees, are of little value. Podium presentations about specific products which are underwritten through honoraria paid directly to the speakers by companies must bear the taint of potential bias. The most appropriate means by which to determine which implant systems and graft materials to utilize is through a combination of critical examination of unbiased literature and discussions with respected colleagues whom you trust to truthfully relate their clinical experiences.

Our patients come to us in trust and ask us to help them. We must be worthy of this trust, as well as being true to ourselves.

To quote the great philosopher Confucius: "There are things you do, and things you do not do."

These choices define us as clinicians, and ultimately as people.

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Case of the Month

Implant Replacement with Minimally Invasive Surgery and Immediate Loading in the Esthetic Zone Utilizing a Zirconia Abutment and Ceramic Restoration

Jaeseok Kim, DMD, MSD, PhD[1] • Chang-Hoon Kim, DDS, MS[1]

Abstract

Background: This case report documents minimally invasive implant surgery with immediate loading and prosthodontic treatment utilizing all-ceramic abutment/restorations. Replacement of teeth in the anterior region is always challenging to the clinician. From the patient's perspective, the esthetic quality of restoration is always of the utmost interest. Our aim was to provide immediate and esthetic restoration to the patient.

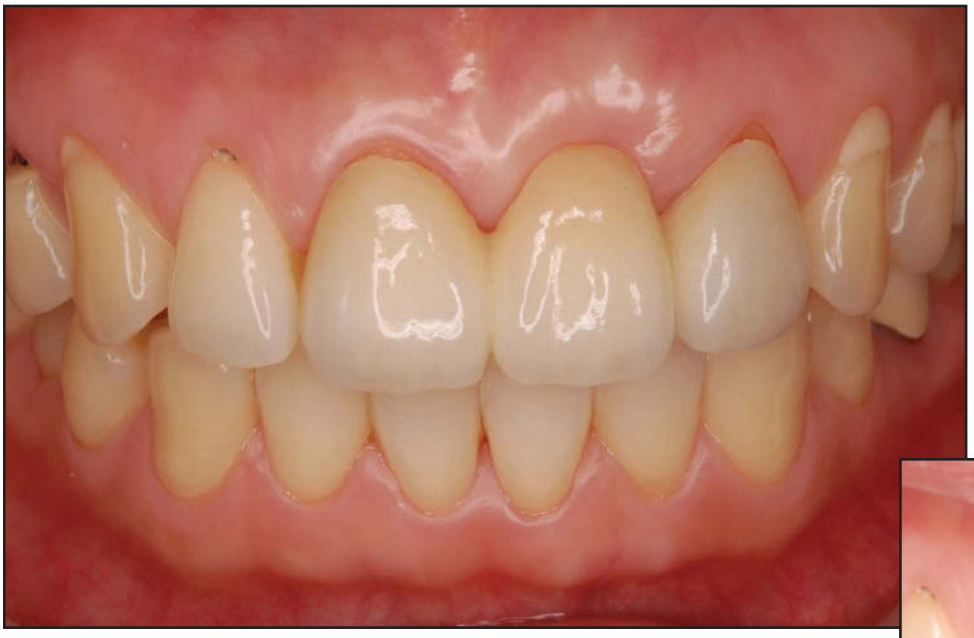
Methods: The patient was a non-smoking 45 year old female with an unremarkable medical history. Her chief complaint was mobility of the bridge in the maxillary anterior region. After removing the 3-unit bridge, intraoral, extraoral, radiographic, and dental computerized tomography examinations were carried out. The treatment plan included extracting tooth #10 and restoring with implant-supported restorations on #9 and #10. After extraction of #10 and making site preparation using tissue punch on the #9 area, (2) 3.75 x 11.5mm implants(Biomet-3i™, Osseotite®, Palm Beach, CA) were placed. The horizontal gap between the implant and socket wall was filled with Oragraft® freeze dried bone allograft (LifeNet Health™, Virginia Beach, VA). Initially, the patient wore a provisional removable partial denture. After a one week healing period, a provisional restoration was delivered. Gingival sculpting was performed by using the provisional restoration. After 12 weeks, final impressions were obtained by the restorative dentist. Zirconia abutments using CAD/CAM (Procera System®Nobel Biocare AB, Göteborg, Sweden) and all-ceramic restorations (LAVA, 3M ESPE, St. Paul, MN) were fabricated and delivered to the patient.

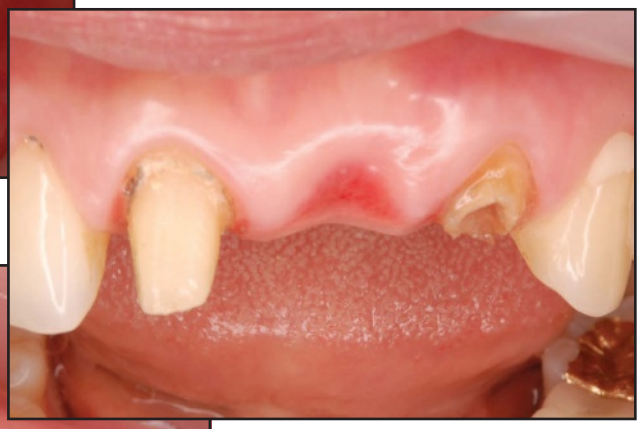
Results: The patient was satisfied, regarding the comfort of the operation and the esthetic quality of the definitive restoration.

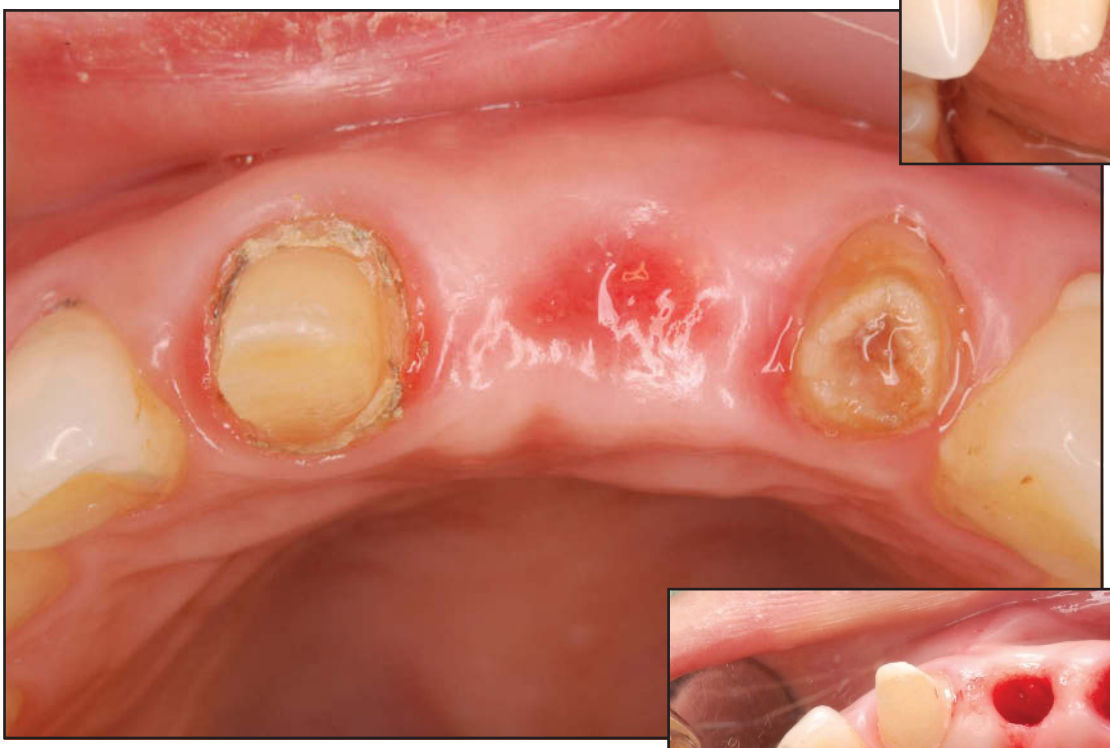
Conclusions: This case report shows that immediate implant placement and immediate loading using zirconia abutments and restorations offers the clinician and patient simplicity and a high level of esthetics

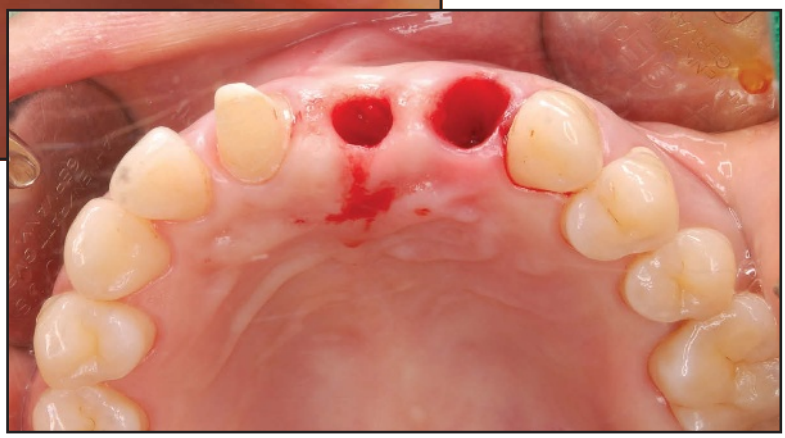
KEY WORDS: Dental implants, immediate placement, immediate loading, ceramic abutment, ceramic restoration, zirconia

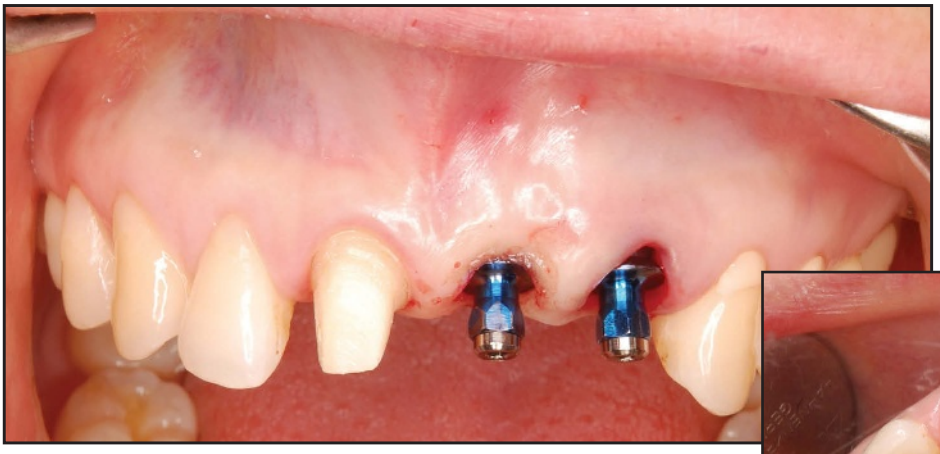
1. Luden Dental Clinic, Seoul, Korea

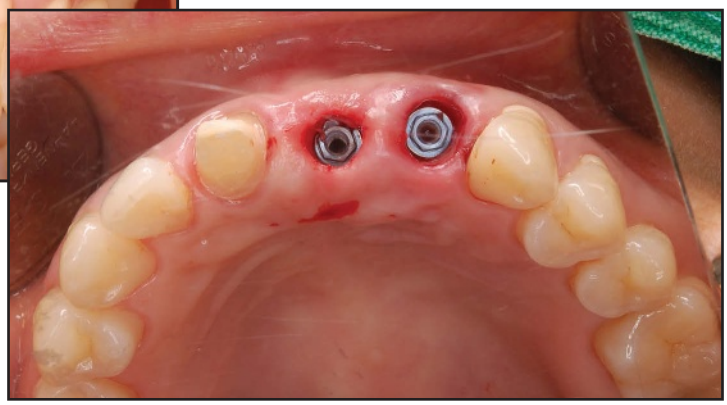


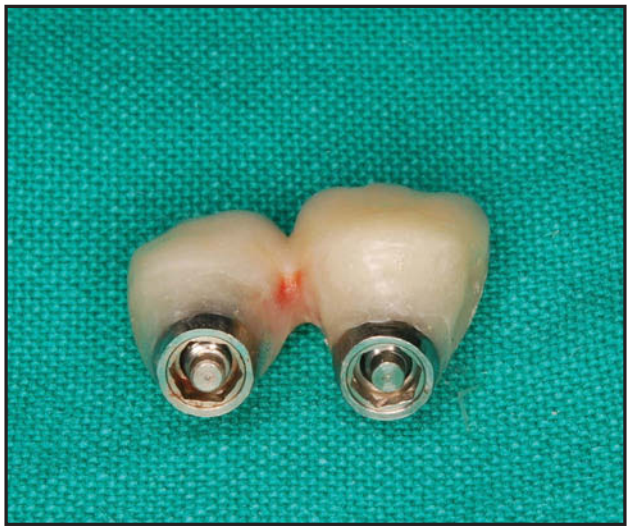


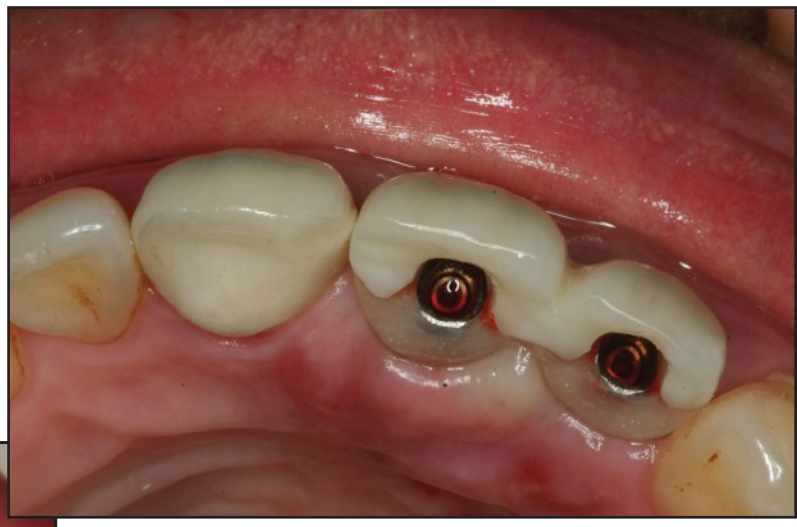


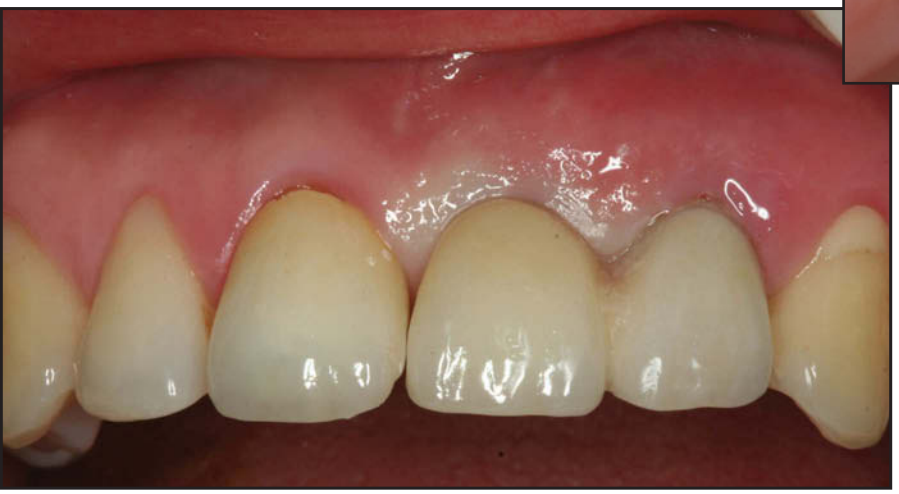


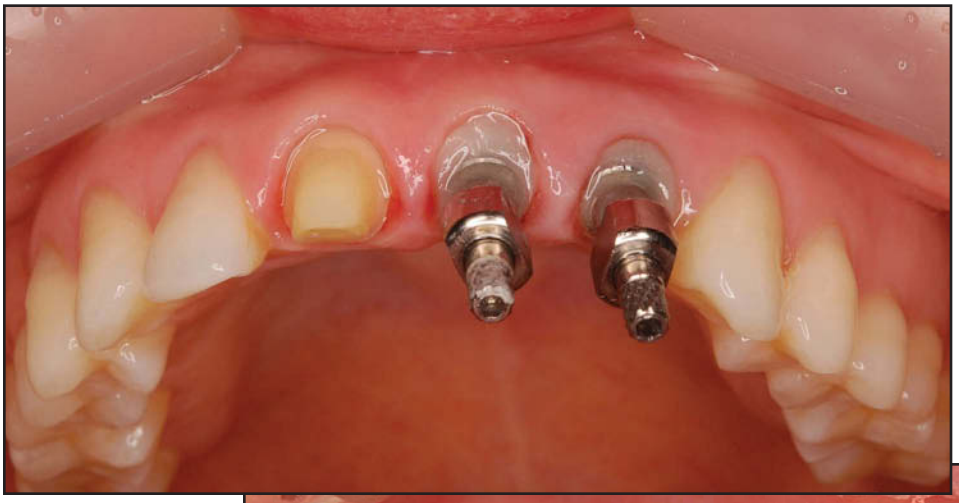


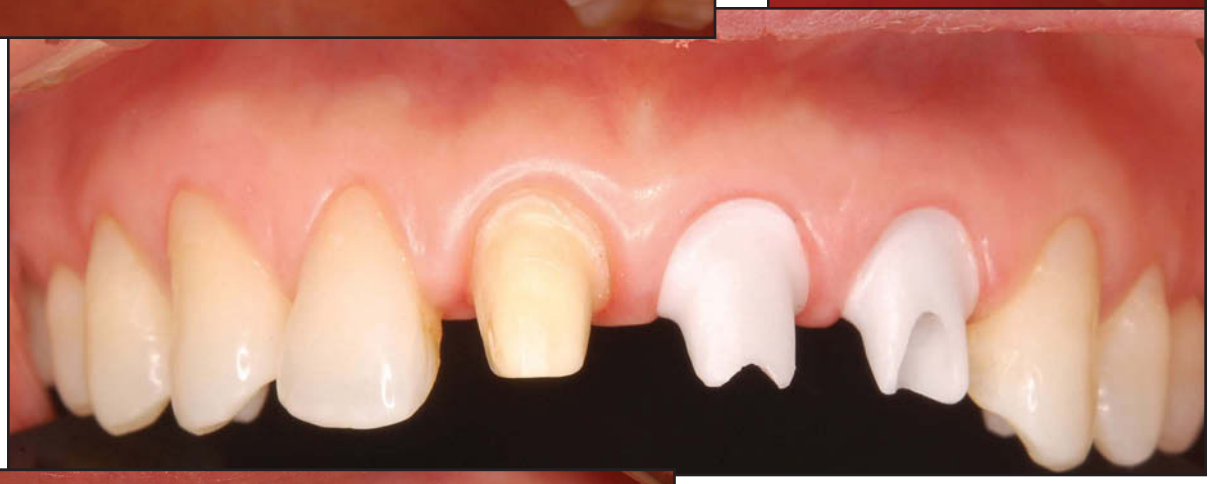


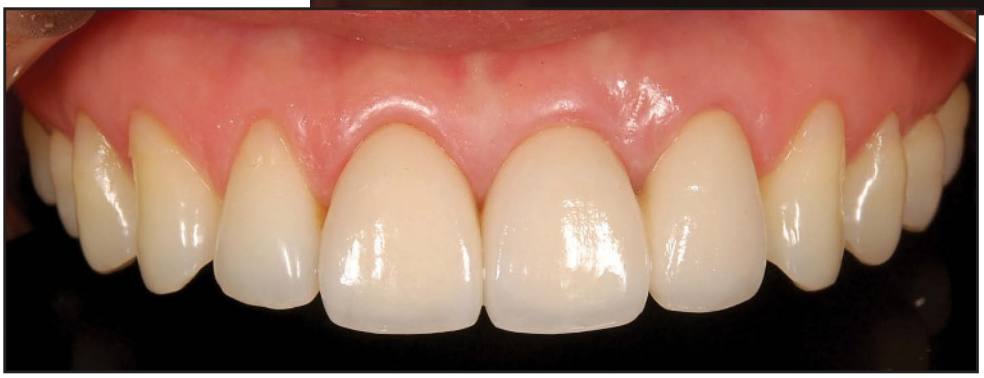


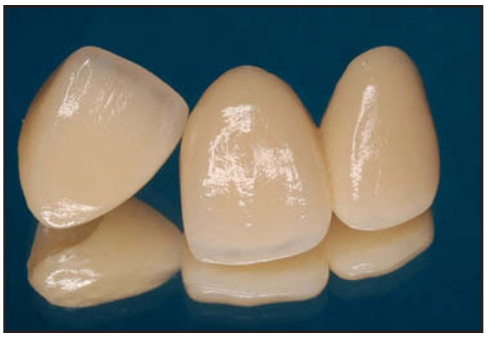












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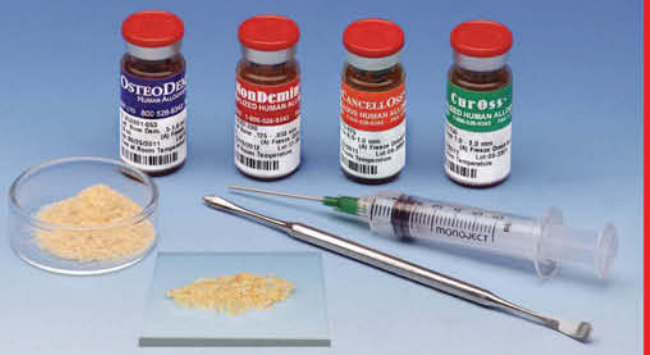

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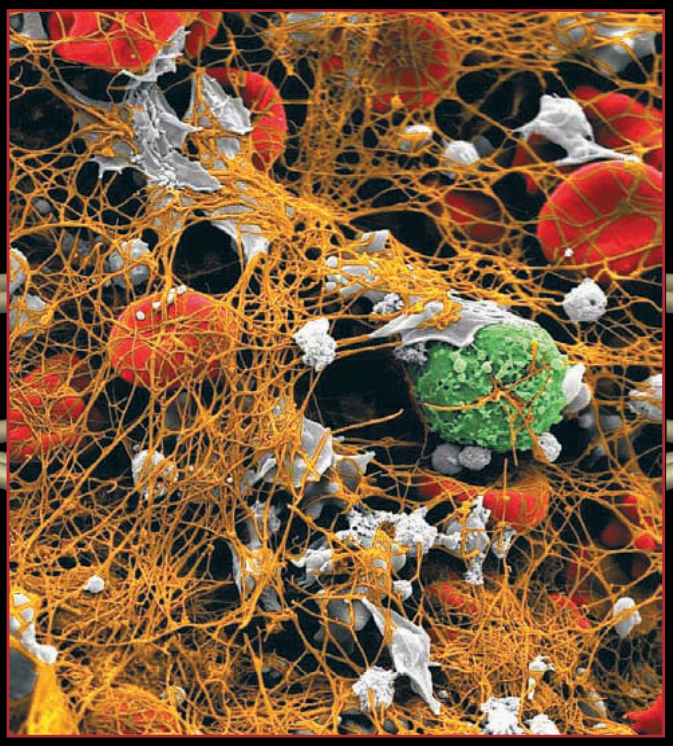

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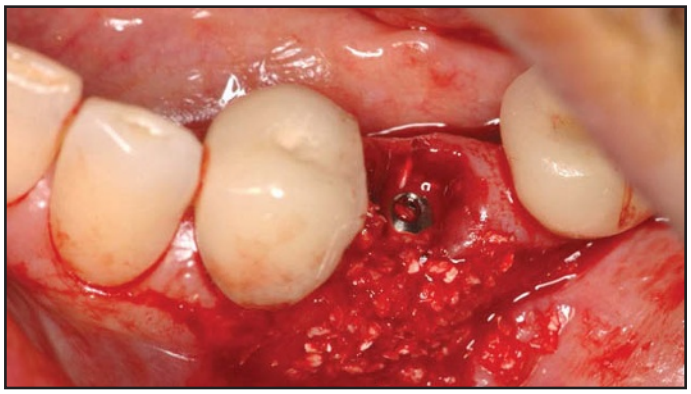
Use of an Autologous Leukocyte and Platelet-Rich Fibrin (L-PRF) Membrane in Post-Avulsion Sites: An Overview of Choukroun's PRF

Marco Del Corso, DDS, DIU[1] • Michael Toffler, DDS[2]
David M. Dohan Ehrenfest, DDS, MS, PhD[3]

Abstract



Choukroun's Platelet-Rich Fibrin (PRF) can be considered an autologous healing biomaterial, incorporating leucocytes, platelets and a wide range of key healing proteins within a dense fibrin matrix. With its strong fibrin architecture and slow release of growth factors and glycoproteins over several days, this natural bioactive membrane can enhance soft/hard tissues healing while protecting both surgical sites and grafted materials from external aggressions. In this article, we propose an overview of the use of PRF in post-avulsion sockets or defects. PRF can be used as a filling material in avulsion (or extraction) sockets alone or mixed with a bone substitute. Used as a covering membrane for guided bone regeneration (GBR), PRF both protects the grafted material and accelerates wound closure, particularly when contiguous suture of the wound margins is not possible. The range of clinical applications of PRF is wide, but an accurate knowledge of the biomaterial, its biology, efficiency and limits is necessary to optimize its systematic use in daily practice.

KEY WORDS: Platelet rich fibrin, platelet rich plasma, autologous growth factors

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3. Researcher, Department of Biomaterials, Institute for Clinical Sciences, The Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden.

INTRODUCTION

The research and development of protocols promoting haemostasis and healing is a recurrent issue in all surgical disciplines. Fibrin is the first matrix in all wound healing processes,[1,2] and the use of fibrin-based surgical additives, mainly fibrin glues, has a long history in oral and maxillofacial surgery.[3-5] The evolution of these techniques resulted in the development of autologous fibrin glues and, since platelets contain a large amount of fibrinogen (the precursor of fibrin), to the concept of platelet concentrate for surgical use. Whitman et al[6] first described the use of these platelets gels. Since the report by Marx et al,[7] these products have been referred to as platelet-rich plasma (PRP), like the transfusional platelet concentrates from blood banks. Most authors refer to these products as a source of autologous growth factors. Unfortunately, the passion for growth factors has lead to an underestimation of the function of leukocyte content and fibrin architecture in the healing equation.[8]

Since these early publications, a variety of autologous platelet concentrate techniques and devices have been developed, marketed and tested in a large number of clinical situations.[9] In periodontal, implant and maxillofacial surgery, platelet concentrates were first used for their release of growth factors to stimulate the healing process. However, the clinical benefit is difficult to evaluate, and the literature is quite controversial on the subject.[8] This is mainly due to the large number of techniques available, and to the absence of clear classification of the different products. Moreover, the PRP's were both expensive and time consuming protocols and their development in private practice remains quite limited. In 2001, a new protocol was suggested in France by Choukroun at al[10] to concentrate platelets and fibrin in a simpler way without blood modification: Platelet-Rich Fibrin (PRF).

DEFINITION OF PRF

PRF can be considered as an autologous healing biomaterial, incorporating in a matrix of autologous fibrin most leukocytes, platelets and growth factors harvested from a simple blood sample.[11-13] At the present time, the PRF protocol is both the most simple and inexpensive way to produce a platelet concentrate.[8] The blood sample is drawn from the patient at the time of the surgical procedure and is treated with a single centrifugation, with a specific centrifuge (figure 1) and collection kit (Process, Nice, France), without blood manipulation: no anticoagulant during blood collection and no bovine thrombin or calcium chloride for fibrin polymerization.[14] At the end of the centrifugation process, three distinct fractions are produced: 1) at the bottom of the tube, red cells are concentrated (and easily discarded); 2) the superficial layer is a liquid serum called platelet-poor plasma; 3) the intermediate fraction is a dense PRF clot, which can then be used clinically in the form of a membrane. The protocol requires a special tool (PRF box, Process, Nice, France) to prepare standardized membranes and to harvest PRF exudate, in a sterile environment (figures 2, 3).

Both PRF exudate and platelet-poor plasma contain significant amounts of growth factors (Transforming Growth Factors TGFβ-1, Platelet-Derived Growth Factors PDGF-AB, Vascular Endothelial Growth Factors VEGF, etc)[12,13] and matrix glycoproteins, particularly fibronectin and vitronectin. Fibronectin and vitronectin are two key proteins for cell-matrix contact; therefore,

Figure 1: PRF specific centrifuge.

using this exudate for biomaterial impregnation may be beneficial. With the PRF Box®, PRF fibrin membranes are obtained with consistent size and thickness (figure 3). This tool is essential to guarantee objective and reproducible results.[15]

The PRF fibrin membrane is more elastic and consistent than the fibrin bulk sometimes obtained with some PRP protocols. PRP's are enhanced fibrin glues, and PRF is a true fibrin-based biomaterial[8] which may be employed in many clinical situations.[16-18] For example, its elasticity allows it to function as a suturable membrane. This biomaterial is both very easy and inexpensive to produce; therefore, its systematic use during oral and maxillofacial surgery must be considered a relevant clinical option. Moreover, it is completely autologous, so there is no ethical limitation or toxicity concerns related to this natural optimized blood clot.[14]

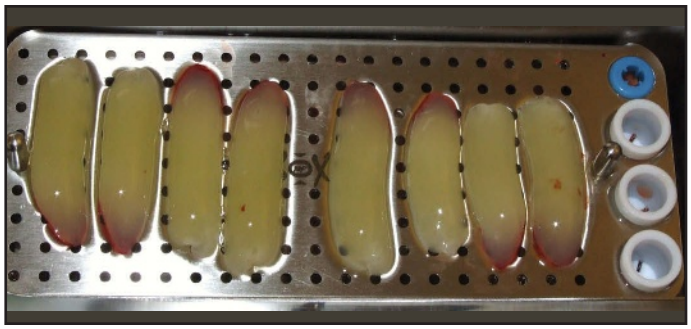

Figure 2: Using the PRF Box, PRF clots are collected and standardized.

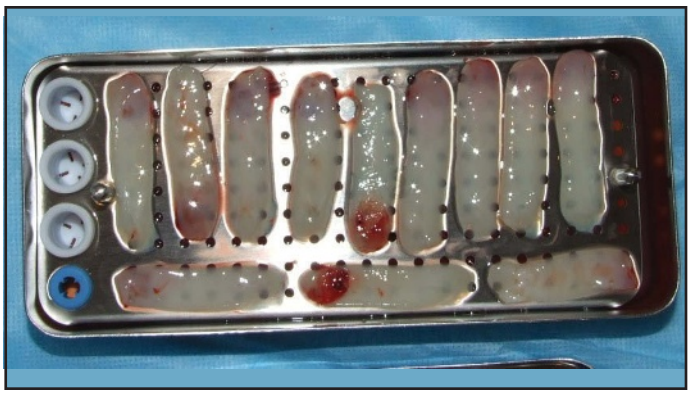

Figure 3: After compression in the PRF Box, uniform PRF membranes are obtained.

PRF: AN AUTOLOGOUS BIOACTIVE MEMBRANE

Recently, a global classification of platelet concentrates was published, and these products are now classified in 4 families related to their leucocytes and fibrin contents.[8] Choukroun's PRF is currently the sole product in the L-PRF class (Leukocyte and Platelet-Rich Fibrin), with both high leukocyte content and strong fibrin architecture. In addition, PRF membranes release high amounts of growth factors such as TGFβ1, PDGF-AB, VEGF and matrix glycoproteins (such as thrombospondin-1) during 7 days *in vitro*.[19] The fibrin matrix with its intrinsic factors and leukocyte content contains the key ingredients for an enhanced healing of superficial

and bone tissues, particularly through the stimulation of neoangiogenesis. It was recently demonstrated in vitro that PRF enhances proliferation of many different cell types such as fibroblasts, osteoblasts, adipocytes, and keratinocytes.[20,21] PRF also stimulates osteoblastic differentiation.[21] The influence of leukocytes was already pointed out in this study, as these cells are true regulation turntables and produce large amounts of VEGF involved in angiogenesis.[19] The PRF fibrin matrix as a filling biomaterial has produced consistently favorable clinical results.[22-24] PRF, as an optimized blood clot, has also been shown to be a very efficient osteoconductive material in sinus-lifts.[25,26]

The PRF protocol is finally a way to transform a natural blood clot into a clinically usable bioactive membrane. The synergetic effects of the fibrin matrix and its growth factor content lead to a natural and enhanced healing of soft and hard tissues. The platelet and leukocyte cytokines are gradually released during fibrin matrix physiological resorption,[19] and matrix glycoproteins allow quick cell migration and proliferation within the PRF tissue-like architecture. This gradual release of cytokines appears to play a regulatory role in the inflammatory phenomena within the wounded tissues. However, the mechanical function of PRF must also be considered since the PRF membranes allow early wound protection and aid in primary soft tissue closure.[17,18,27] This technique, which mimics the natural coagulation process, produces an inexpensive and simple bioactive membrane. Many researchers have tried to develop such membranes in artificial ways by incorporating growth factors in collagen membranes for example. This simple PRF technique produces the most natural bioactive product currently available.

USING PRF IN DAILY PRACTICE FOR POST-AVULSION SITES

The management of avulsion or extraction[28] sites is a daily issue since bone resorption following tooth removal can compromise both implantation and aesthetic results. For this reason, it is often recommended to insert a filling material inside the residual avulsion socket to maintain adequate bone volume. Many bone substitutes function primarily as a space-maintainer. However, these materials are often quite slow to resorb and remodel, and their use often delays the vascularization and bone regeneration at the site. In addition, the management of soft tissue over the graft requires flap release, extensive dissection, and vertical incisions in order to cover the grafted volume, reducing microvascularization at the margins. Used in this indication, PRF acts in the following ways as an optimized blood clot to enhance the natural healing process:

As a filling material in avulsion sockets,[22] PRF will act as a stable blood clot for neovascularisation and an accelerated tissue reconstruction (figures 4-8),[2] particularly in infected sites or in patients with medical conditions that may delay healing (eg. diabetes, immunosuppression). PRF stimulates both coagulation (with thrombospondin-1) and wound closure, making it a useful adjuvant in patients under anticoagulant therapies.

As a membrane for guided bone regeneration (GBR), the PRF dense matrix architecture covers, protects, and stabilizes the bone graft material and the operative site in general.[17] Particularly, the elasticity and strength of the PRF fibrin membrane makes it easy to suture. When the socket is too wide for primary closure, the PRF fibrin matrix can be used as a covering and protective membrane that promotes re-

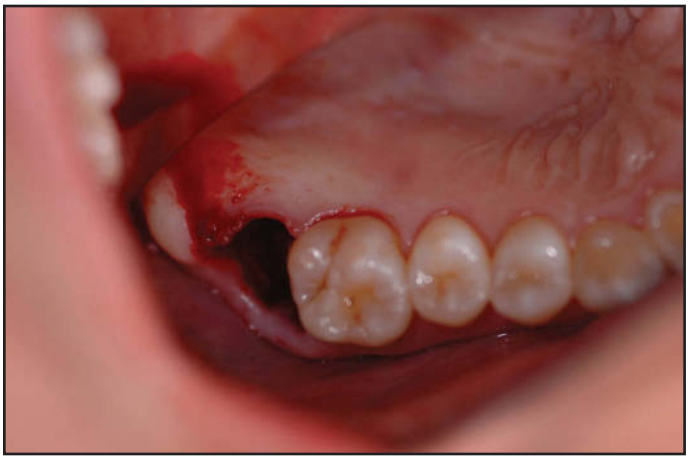

Figure 4: Avulsion/Extraction of tooth 15.

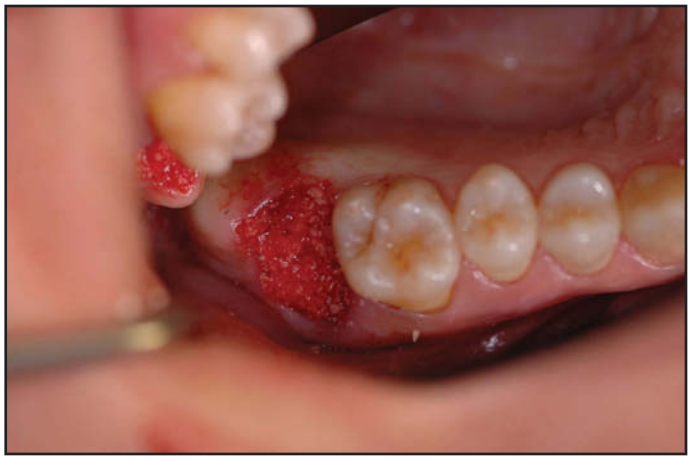

Figure 5: Preservation of site 15 with allograft.

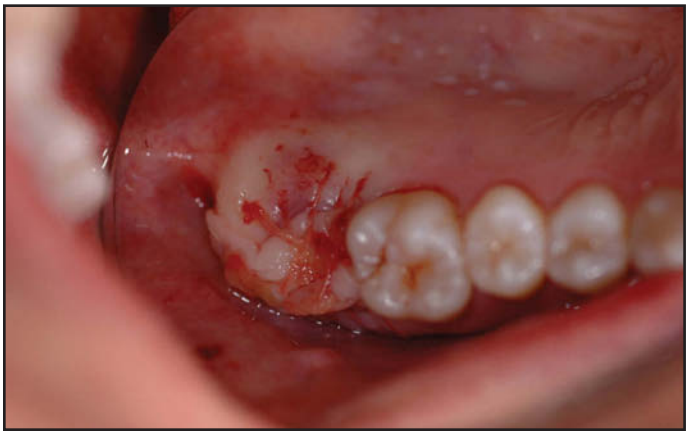

Figure 6: Placement of PRF membrane. Primary closure not required.

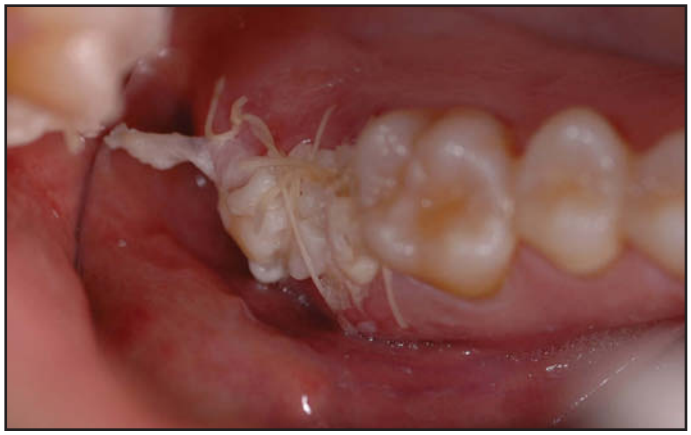

Figure 7: Healing at 24 hours. The PRF membrane protects the socket and stimulates wound healing.

epithelialization of the site and accelerates the merging of the gingival margins (figures 9-22). However, in such circumstances, several PRF layers are required to adequately protect the grafted material and achieve the desired effect.

The mechanisms of these 2 common applications are in fact similar. Epithelial and connective tissue healing on PRF membranes is related both to the growth factors and the fibrin matrix.[1] Gingival fibroblasts easily migrate into this matrix and remodel it. The acceleration of the healing process makes the surgical site less sensitive to

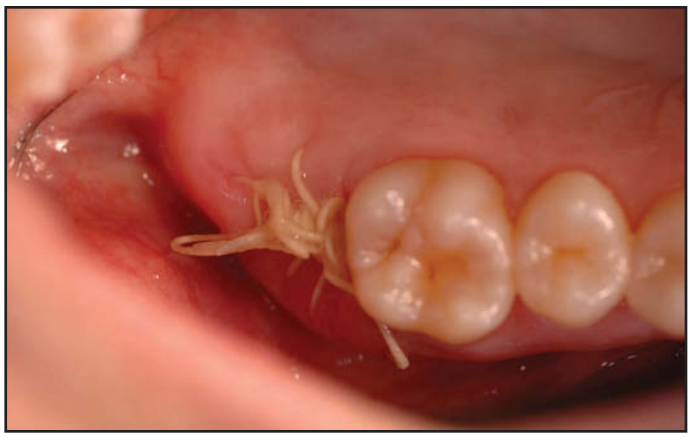

Figure 8: Healing of site 15 at 15 days post-op.

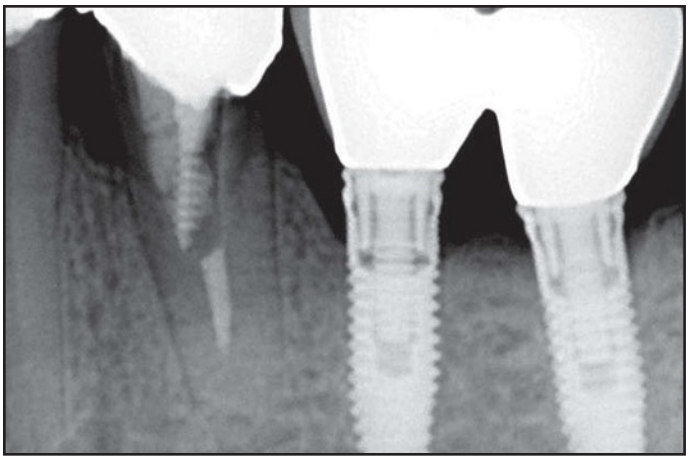

Figure 9: Radiograph of fractured tooth 20.

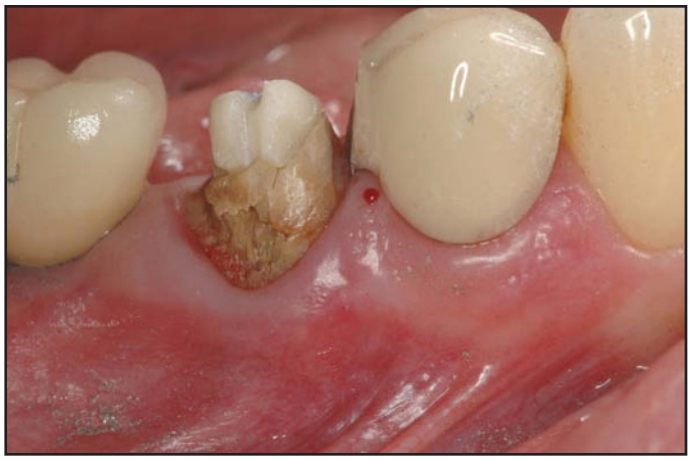

Figure 10: Intraoral view of fractured tooth 20.

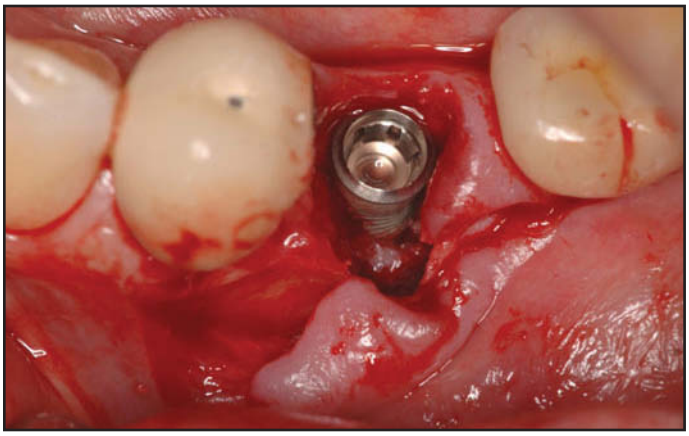

Figure 11: Tooth 20 was avulsed/extracted and immediately replaced with an implant (Intra-Lock, Boca Raton, FL, USA).

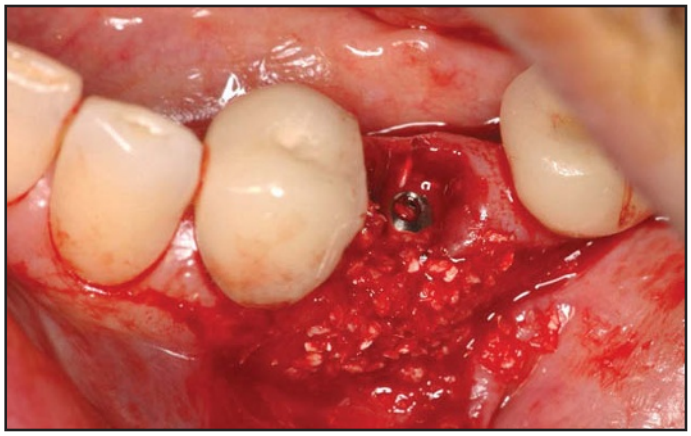

Figure 12: A cortico-spongious porcine bone (GenOs, Osteobiol, Tecnoss Dental, Turin Italy) mixed with PRF was grafted in the defect.

aggressions (mechanical, bacterial and chemical) and thus positively influences both the aesthetic result and postoperative sensitivity. At a deeper level, PRF increases the cohesion between the graft materials as fibrin acts as a physiological glue between wounded tissues. Natural blood coagulation leads to the formation of a fibrin matrix that biologically links wounded tissues together allowing cell proliferation, cell migration, neomatrix apposition and remodelling. Therefore, the combination of PRF with different kinds of filling materials should improve the integration of the grafted material, since PRF is an optimized blood clot.[25]

However, even though these mechanisms are quite well known, the ideal application of PRF must still be accurately defined.[15] The filling of avulsion sockets with PRF leads to very favourable results when the bony walls are intact. A combina-

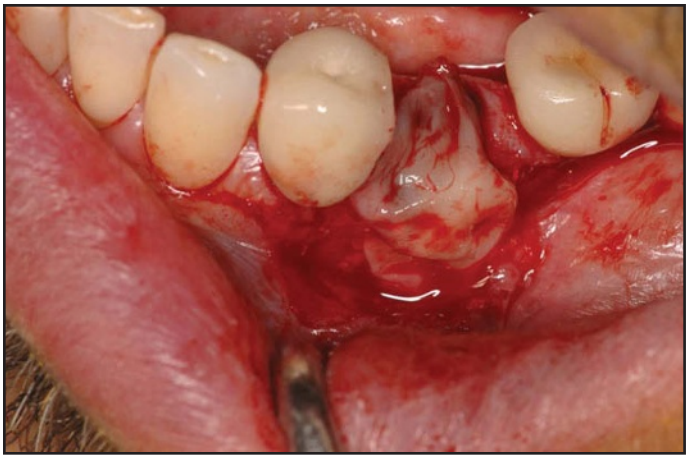

Figure 13: PRF membrane used to cover graft.

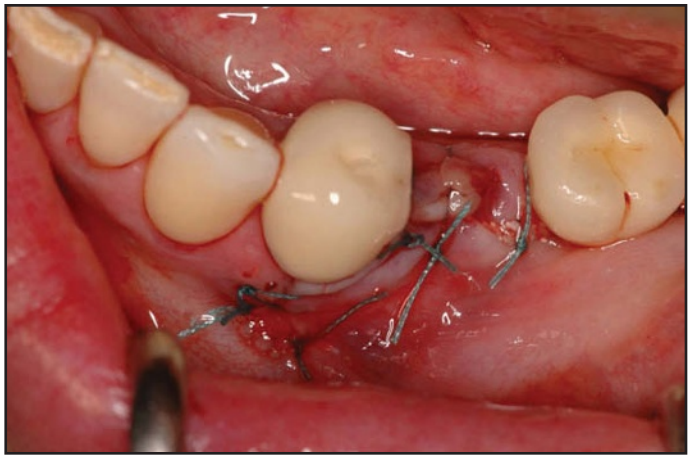

Figure 14: Closure of surgical site with some PRF membrane exposed.

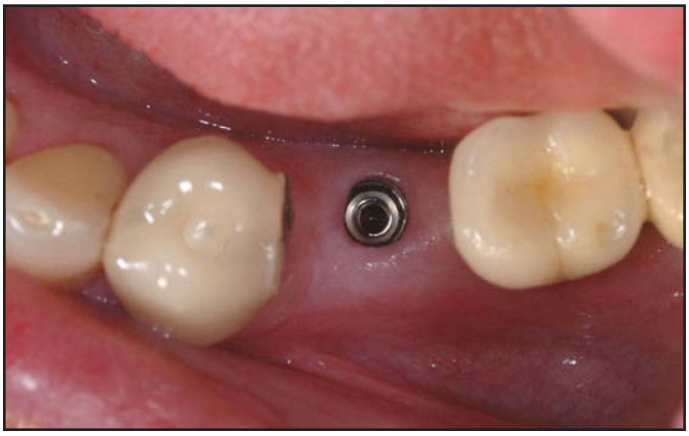

Figure 15: Healing at 3 months post-op.

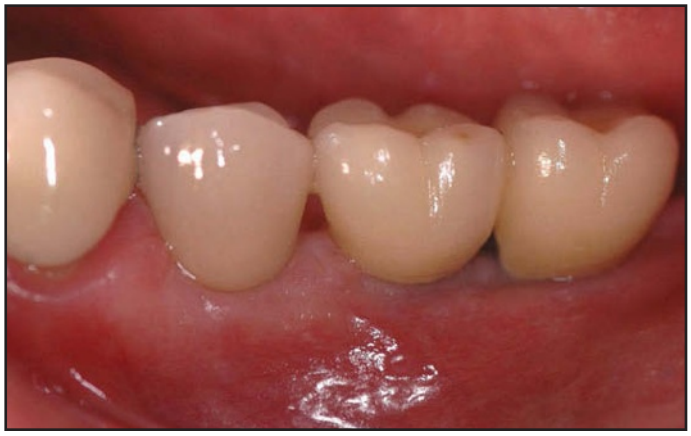

Figure 16: Final implant supported prosthesis.

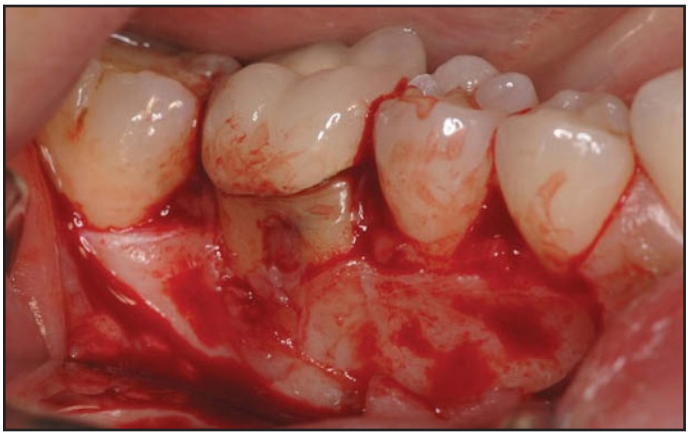

Figure 17: Pre-op view of hopeless tooth #30.

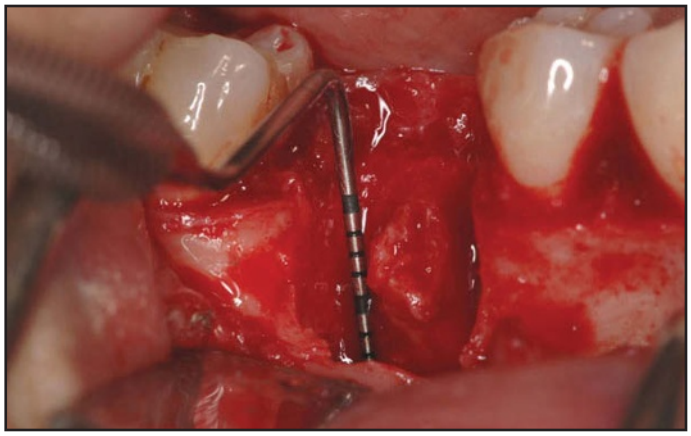

Figure 18: Resulting periodontal defect following removal of tooth #30.

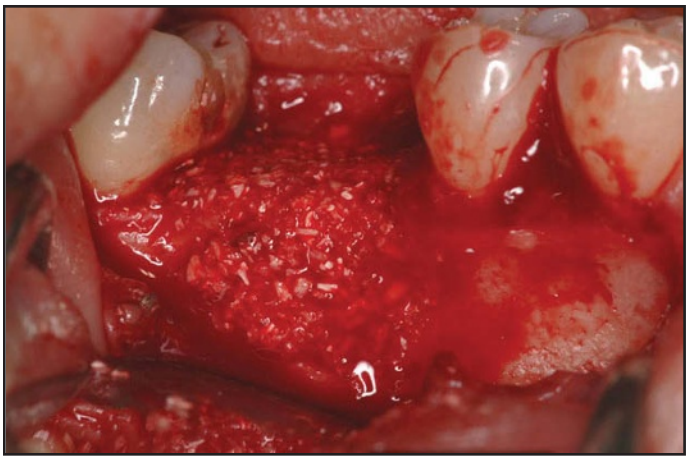

Figure 19: Bone graft + PRF mixture added to site #30.

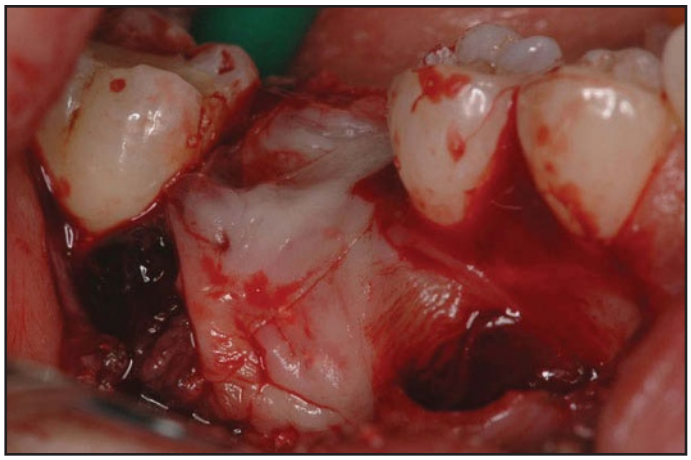

Figure 20: Graft covered with PRF membranes.

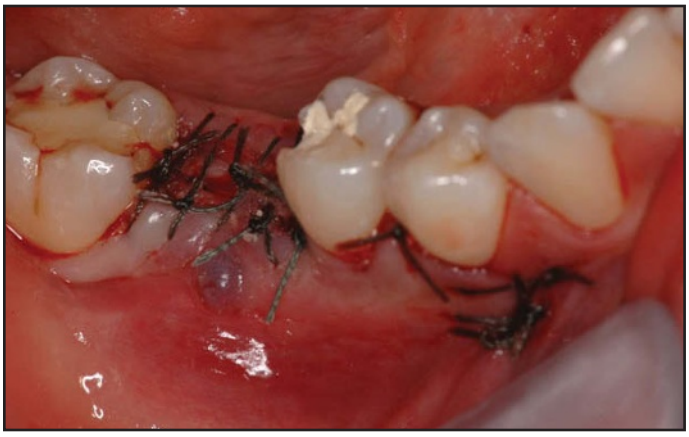

Figure 21: Mucoperiosteal flap closure.

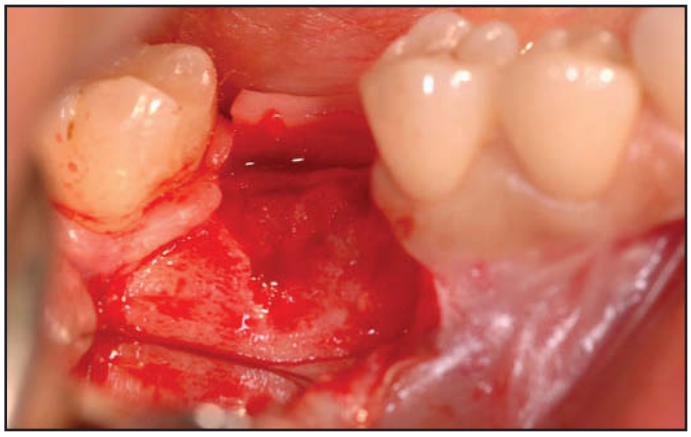

Figure 22: Bone healing at 3 months.

tion of PRF with bone substitutes and other adjuvants may be necessary in residual defects where one or several walls are missing or damaged in order to predictably provide an adequate reconstitution of bone volume.[17,18,29] In all cases, the systematic use of PRF leads, in our experience, to optimized gingival and bone regeneration which is particularly useful in implant site development.

CONCLUSIONS

The clinical benefits for the systematic use of PRF in daily practice are many. Inexpensive and simple to handle, this technique leads to the production of a large quantity of bioactive autologous membranes with a powerful healing potential on both soft and hard tissues. Its range of clinical applications in oral and maxillofacial surgery is wide; as a filling material or protective membrane, and often as both. Used as a covering membrane, PRF accelerates healing and closure of the wound margins, stabilizes graft materials, and protects the surgical site from external aggressions. It generally provides a perceptible reduction in superficial tissue healing time, and patients often declare reduced postoperative pain. Mixed with graft material,

PRF will serve as biological cement between the particles and enhance neoangiogenesis and bone regeneration, particularly in stimulating osteoblastic proliferation and differentiation. However, this material is only an optimized and usable blood clot. Its potential applications are broad, but an accurate working knowledge of the biomaterial, its biology, efficiency and limits are necessary to optimize its use in daily practice. Therefore, additional studies evaluating the use and performance of PRF are warranted.

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Disclosure
The authors report no conflict of interest with any products mentioned in this article.

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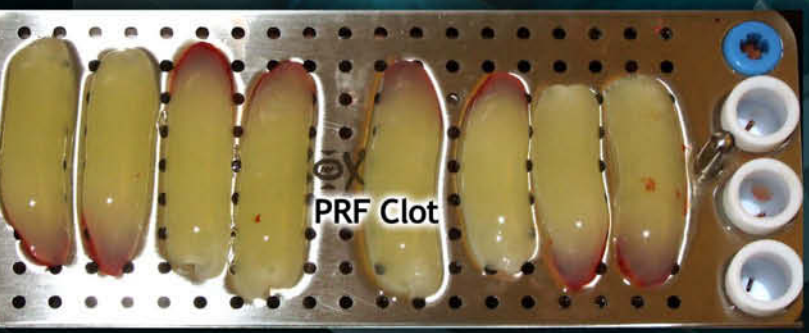
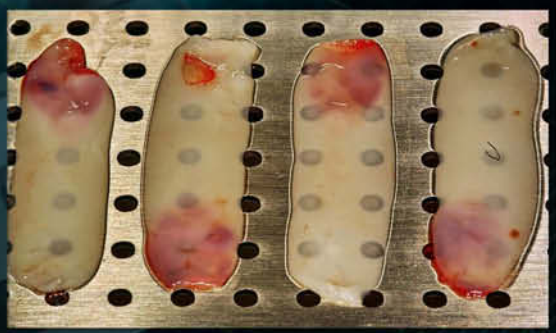
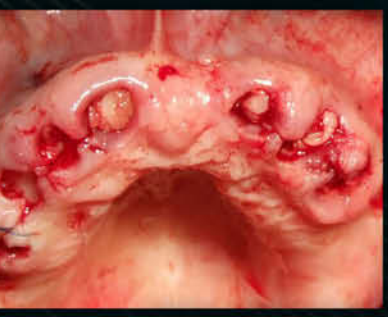


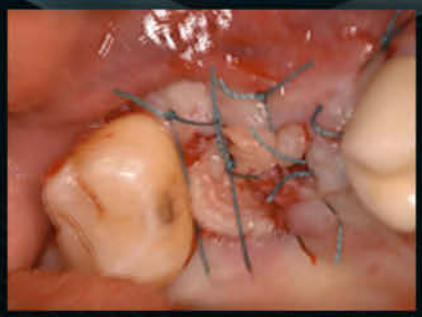
Clots in the PRF Box



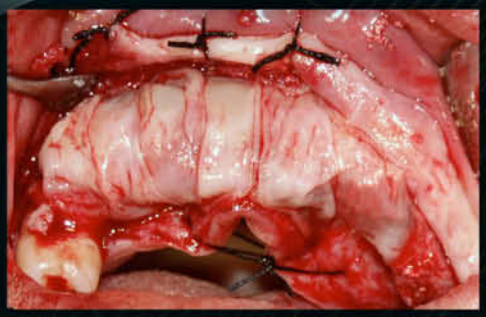
PRF membranes

PRF membrane

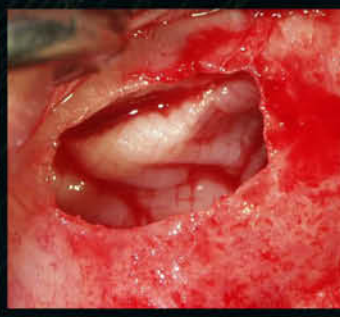




PRF as filler in the socket extraction



Graft protection with PRF



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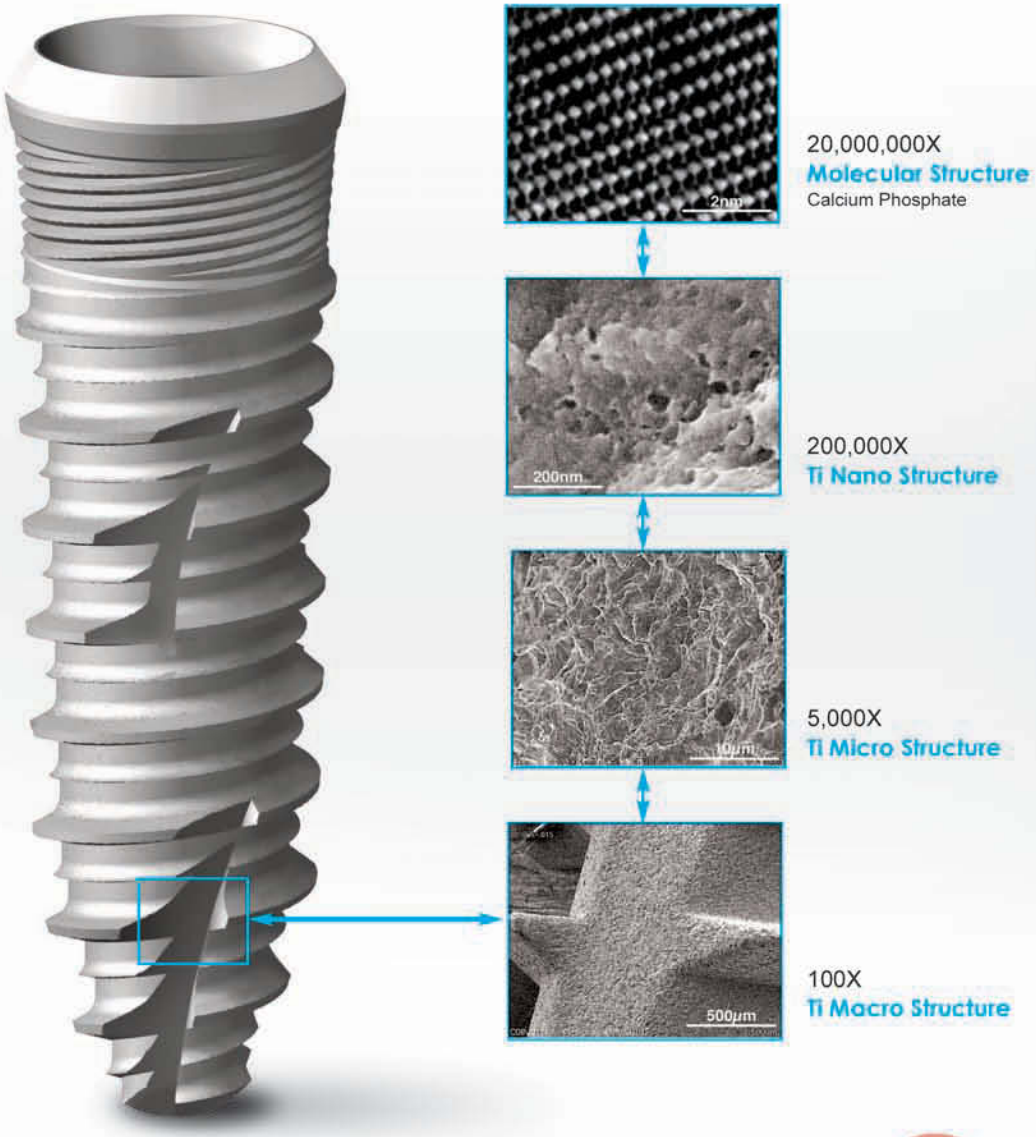

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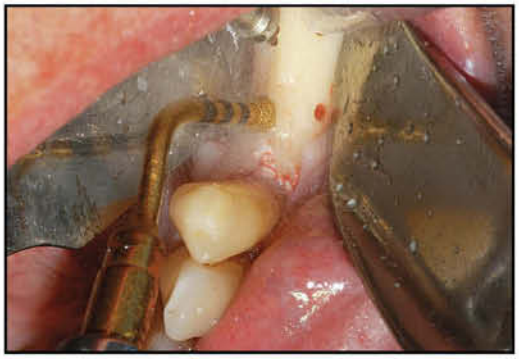

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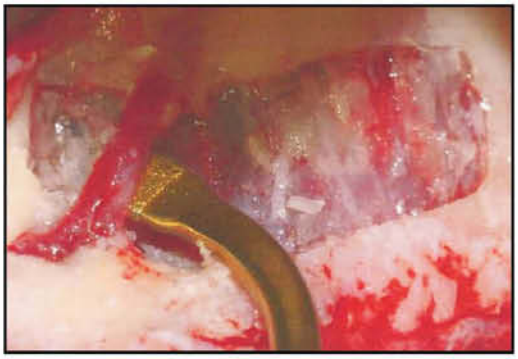

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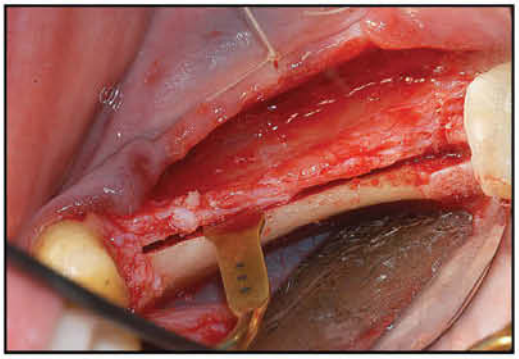

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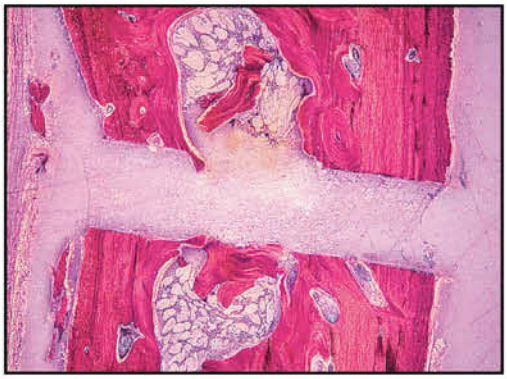

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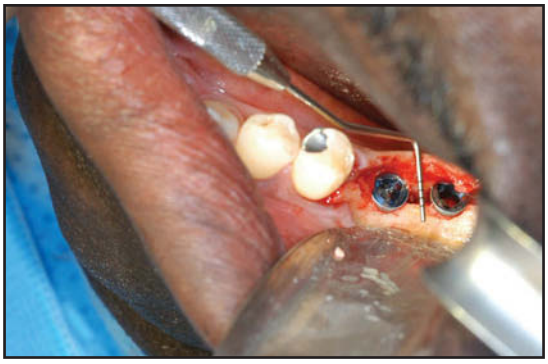
Ridge Split Technique Using Ultrasonic Surgical System: A Case Report

Kurt G. Hummeldorf, DMD[1] • Brian B. Chang, DMD[2] • Philip Vance, DMD[3]

Abstract



Background: Traditional methods of ridge augmentation to include bone grafting from various sources, which increases morbidity and time span for treatment. The ridge split technique may provide an alternative option for dental implant placement on an alveolar width deficiency.

Methods: A ridge split osteotomy was performed on bilateral mandibular edentulous sites using the VarioSurg® ultrasonic surgical system. The initial ridge expansion was obtained with osteotomes. This step was followed by an alternating sequence of manual delivery of fixtures to gain additional alveolar expansion.

Results: Surgical treatment and implant placement were carried out without complications. Patient had uneventful follow ups and is pending osseointegration for prosthetic restoration.

Conclusions: A ridge split technique can provide the alveolar width increase needed for immediate implant placement in an atrophic mandibular ridge with a shorter treatment time and a successful and predictable outcome.

KEY WORDS: Ridge split, atrophic mandibular ridge, dental implant

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INTRODUCTION

Bone volume is crucial to placement of dental implants. Different techniques have been reported to improve on the inadequate bone volume often seen after dental extractions.[1] Guided bone regeneration, autogenous grafts, and alloplastic grafts are techniques to enhance bone volume, but these procedures add cost and require either increased healing time or additional surgical sites depending on the technique.[2] Split ridge techniques have advantages over other forms of maxillary and mandibular atrophic ridge augmentation. The split ridge technique allows for immediate placement of implants, shorter treatment time, and decreased cost.[3] This technique heals similar to a socket and does not require a second surgical site; but like other ridge augmentation techniques, it is limited to increasing alveolar width and has limitations on vertical height.[4] This report will show that with proper case selection and surgical design, a split ridge technique can provide the bone volume needed for implant placement in an atrophic mandibular ridge, with shorter treatment time and successful and predictable outcomes.

CASE REPORT

A 49-year-old active duty male presented to the National Naval Medical Center Oral and Maxillofacial Surgery clinic for implant evaluation. The patient was referred by a general dentist for bilateral mandibular fixed partial dentures (FPD) that were failing due to recurrent decay. Upon clinical and radiographic examination, the patient was diagnosed with bilateral acquired edentulism at sites 18-19, 30-31, and failing FPD's spanning 17-20 and 29-32. Due to his long history of edentulism, the patient had acquired atrophy of bilateral edentulous ridges. He had adequate vertical height but lacked width for implant placement. Various options of ridge augmentation were offered to the patient and the ridge splitting technique was chosen over other options of bone grafting to eliminate donor site morbidity and minimize treatment time.

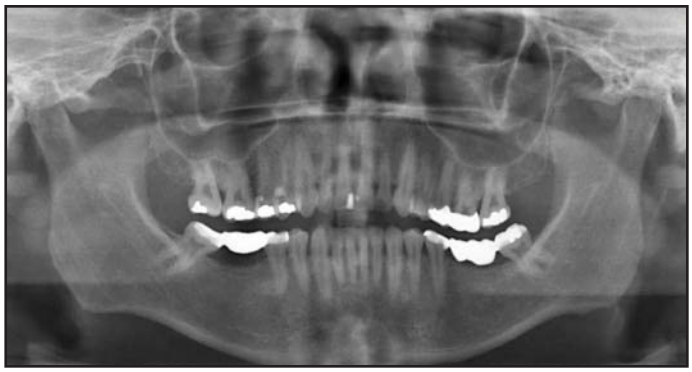

Figure 1: Presurgical radiograph.

The FPD's were sectioned and removed by a prosthodontist prior to the procedure. The patient was taken to the main operating room and general anesthesia was administered. After local anesthesia infiltrations on the right mandible, a crestal incision was made from the distal of site 29 to 32. A full thickness mucoperiosteal flap was elevated minimally buccally and lingually to preserve the periosteum. The atrophic ridge was identified and lack of width was noted. At this time, a prefabricated surgical guide was placed on the edentulous site and used to make an indentation on the alveolar ridge for planned implant placement. The malposed third molar was extracted at this time. Using the VarioSurg® ultrasonic surgical system, a mid-ridge osteotomy was made on the alveolar crest from mesial of site 29 to the extraction socket of tooth 32 connecting the indentations previously made with surgical guide. The

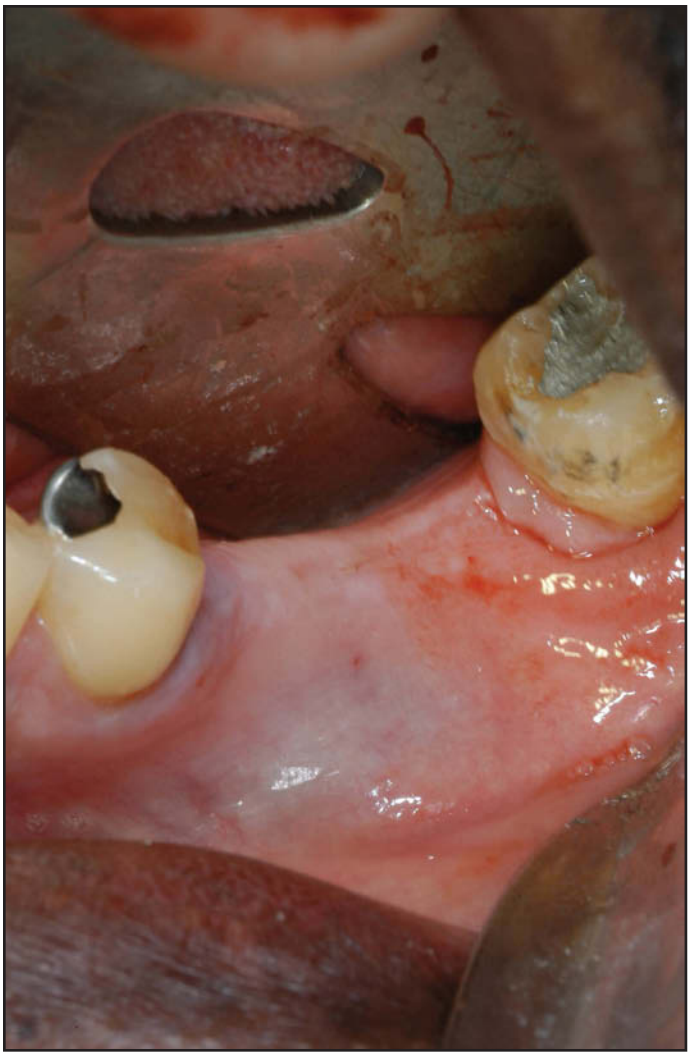

Figure 2: Partial edentulous left mandible.

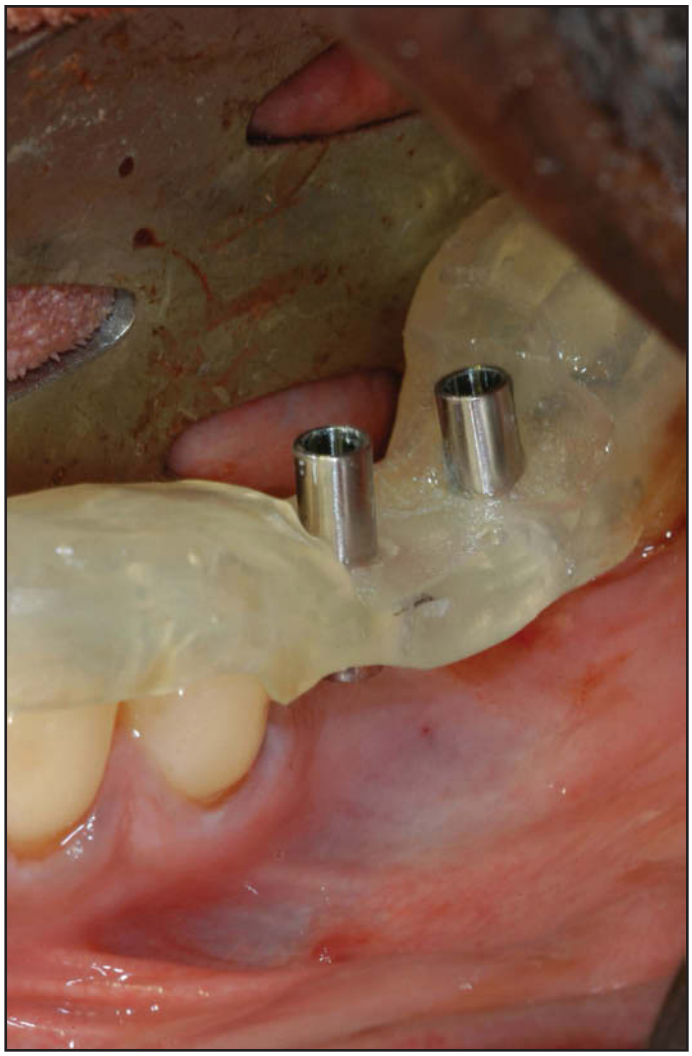

Figure 3: Surgical guide in place.

osteotomy was made just through the cortex at the height of the alveolar crest. Next, the edentulous ridge was expanded with gradual osteotomes that are also used for sagittal split osteotomies. The planned implants to be used for the case were WP (5) x 13mm, tapered. Both sites were prepped with incremental drills up to RP (4) size. Also the depths were only drilled to about 2/3 of the bur, ~10mm. After making the osteotomies, two implants were then placed with 45N torque with approximately 1/3 of the fixtures engaged in the mandible. Using the manual torque wrench, in alternating fashion, the fixtures were further driven into the osteotomy site. The torque wrench was advanced about 6 rotations per implant in alternating sequences to apply equal pressure in the osteotomy site and obtain even expansion. Demineralized freeze dried bone allograft (DFDBA) was placed into the extraction socket and expansion defect. Closure was performed in standard fashion. A similar procedure was carried out on the opposite side without placement of DFDBA.

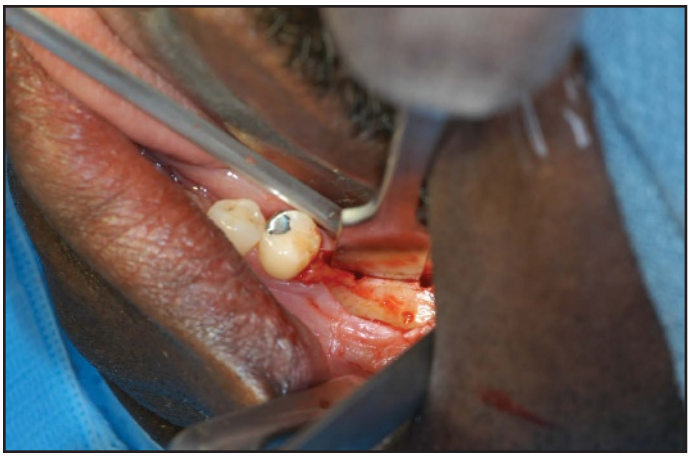

Figure 4: Osteotome expansion of the edentulous ridge.

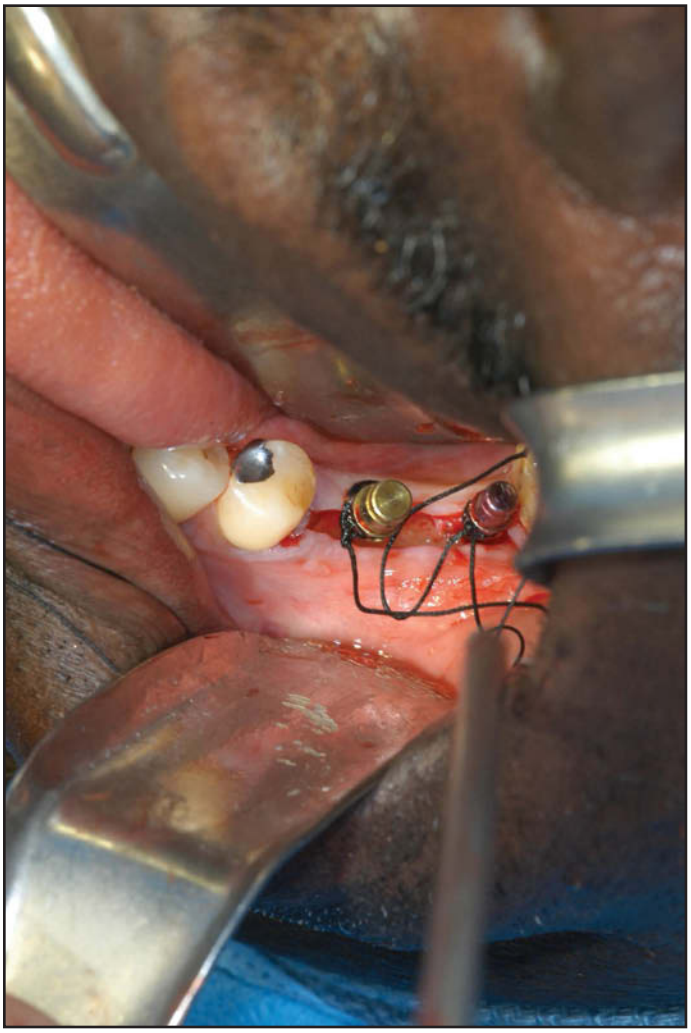

Figure 5: Osteotomy verification with direction indicators.

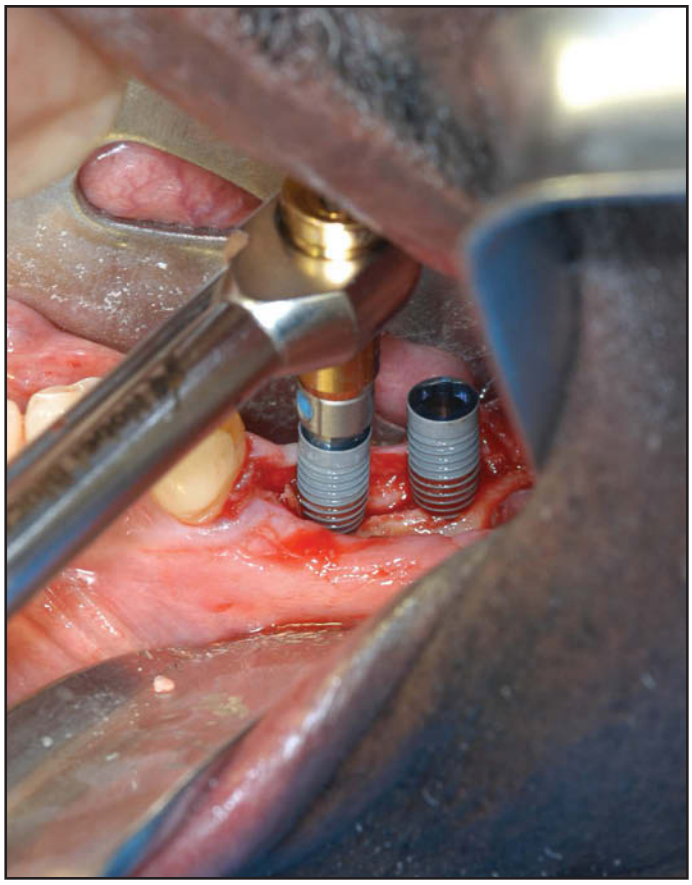

Figure 6: 5 x 13mm fixtures placed at 45N.

DISCUSSION

The ridge splitting technique is a viable alternative to other bone graft augmentation techniques. It has advantages over autogenous block grafting due to elimination of donor site morbidity and decreased treatment time. Requirements for the split ridge technique are: a) a ridge with deficient alveolar width but adequate bone height; b) appropriate interarch space; c) suitable amount of cancellous bone between cortical plates.[5]

The technique used in the procedure presented in this article is as described by Simion *et al.* in 1992 with modifications as described by Vercellotti in 2000 and by Coatoam and Mariotti in 2003.[6-8] Simion introduced a split crest

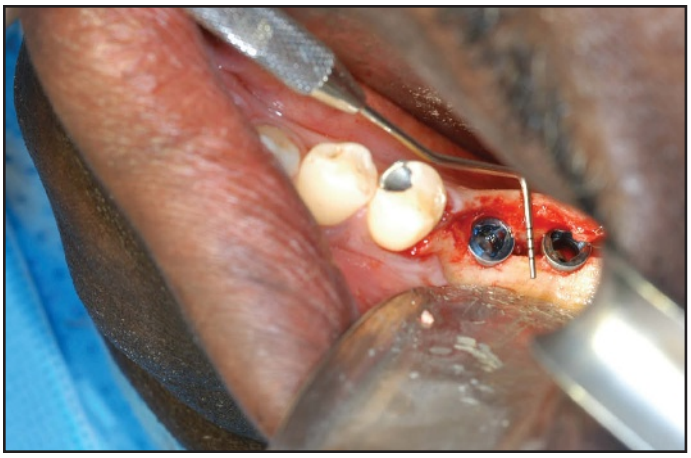

Figure 7: Fixtures delivered and ridge expansion measured.

bone manipulation technique that created a greenstick fracture at the crest of the alveolus that would split the atrophic ridge into two parts allowing enough bone width for implant placement. Vercellotti successfully performed an entire edentulous ridge expansion of 3 mm using a modulated frequency piezoelectric energy scalpel. Coatoam and Mariotti reported good results in 500 cases starting in 1995 using split ridge techniques and heme-reconstituted demineralized freeze-dried bone (DFDBA).[8] The technique employed in this article is a single staged implant approach where the fixture placement is used to simultaneously expand the ridge in a controlled fashion. Scipioni et al. reported 99% survival rates for 329 implants placed in 170 patients by using the one-stage immediate placement edentulous ridge expansion technique.[9]

While the split ridge technique does have advantages, it also has limitations. Intraoperative complications may include: a) intraoral instability of the dental implants; b) fracture of the alveolar ridge and compromised implant placement. After a dental extraction, the buccal ridge resorbs more than the palatal ridge, creating an

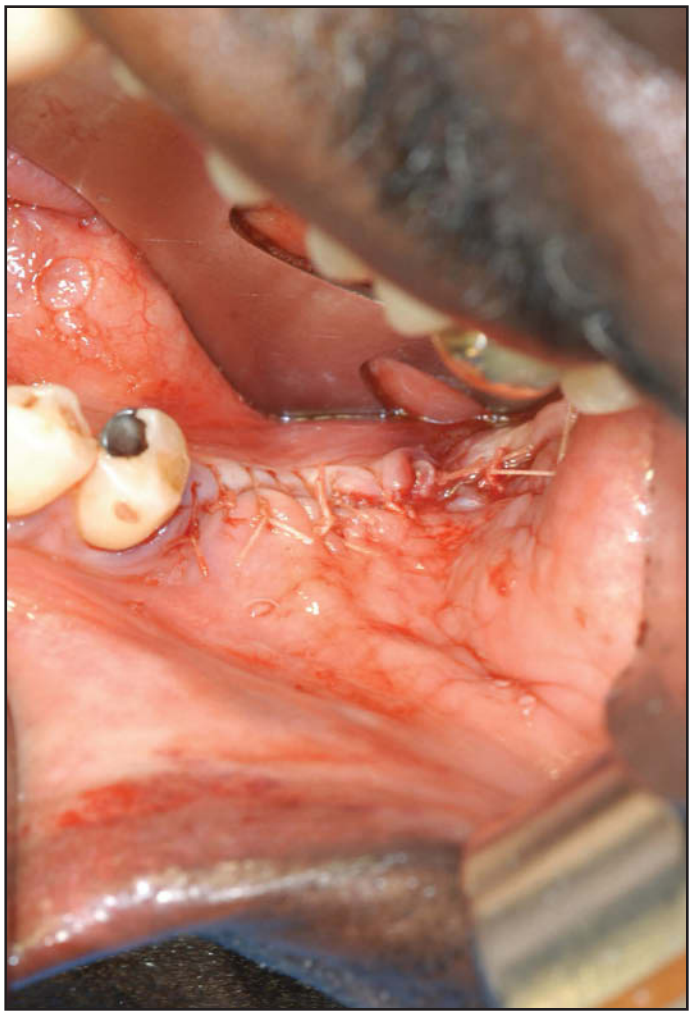

Figure 8: Mucosal closure.

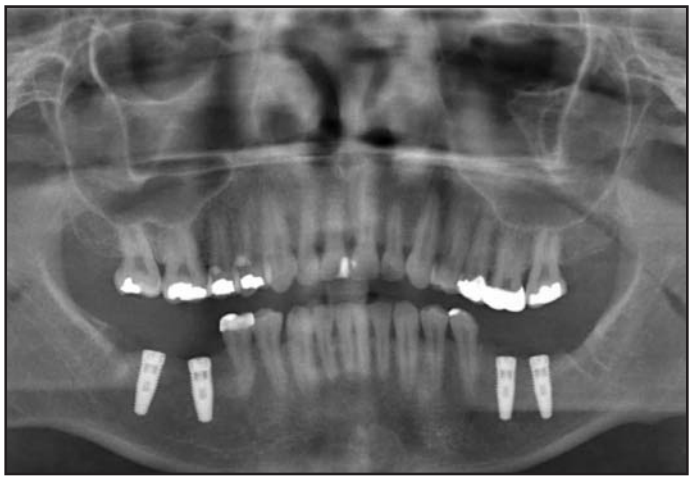

Figure 9: Postsurgical radiograph.

increased likelihood that at the time of the split ridge technique the buccal plate will not be positioned appropriately, causing a compromised implant placement.[10] Postoperatively, dehiscence of the buccal plate, crestal bone loss, soft tissue recession, and lack of osseointegration have been associated with the split ridge technique.[11]

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Disclosure
The authors report no conflicts of interest with anything mentioned in this article.

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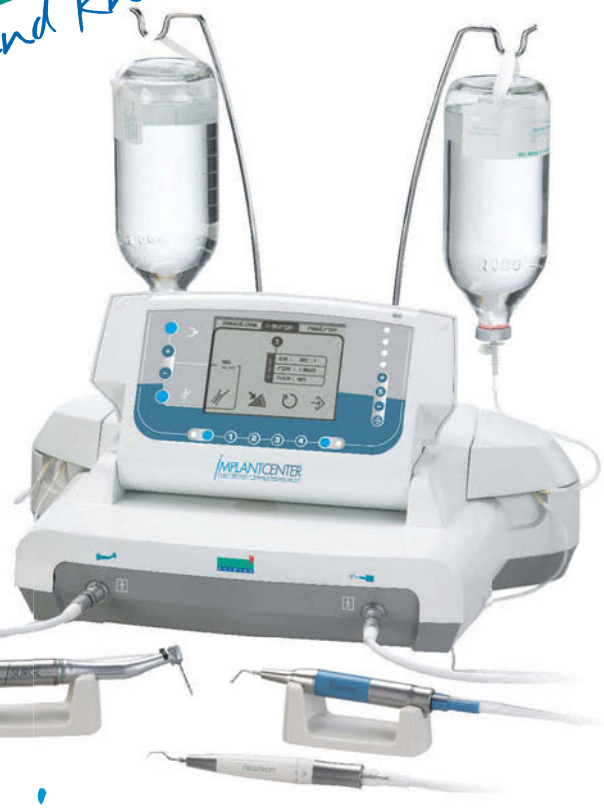

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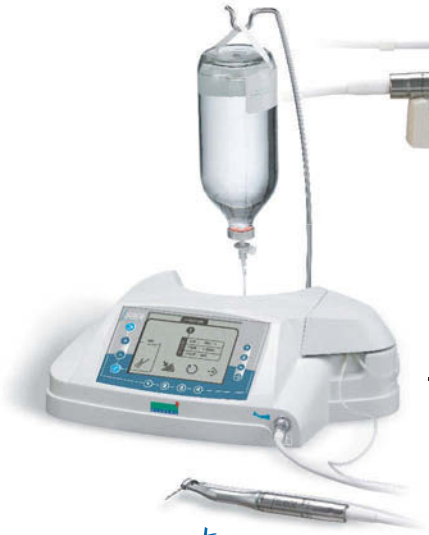

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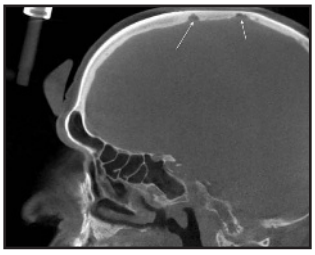
Evaluation of Maxillary Osseous Lesion using CBCT in a Patient with Multiple Myeloma

Werner Harumiti Shintaku DDS, MS[1] • Marcel Noujeim DDS, MS[2]
Vidya Sankar DMD, MHS[3]

Abstract



Background: Multiple myeloma (MM) is a malignant disease that affects the skeleton and bone marrow. MM lesions can be found in bones of the head and neck which may be detected on intra and extra-oral radiographs.

Methods: On a periapical film taken in 2007, a 75-year-old male presented severe alveolar bone loss and a detached small bone fragment on the radicular distal aspect of tooth #11. The patient was diagnosed with MM in 2000. MM lesion was suspected and a cone-beam computed tomography (CBCT) was acquired.

Results: The findings were indicative of periodontal bone loss rather than a myeloma associated lesion, however other structures within the field-of-view could be assessed and previously undiagnosed MM lesions were detected.

Conclusions: Dentists pay a vital role in the detection and diagnosis of suspicious imaging findings as they may indicate involvement or reactivation of MM. CBCT is a valuable tool in the care of these patients and the detection of new MM lesions underscores the necessity of all CBCT images to be verified by oral and maxillofacial (OMF) radiologists.

KEY WORDS: Multiple myeloma, imaging, cone-beam computed tomography, CBCT

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BACKGROUND

Multiple myeloma (MM) is a clonal plasma cell malignancy and the most common primary malignancy to affect the skeleton and bone marrow. It accounts for approximately 1% of all cancers, more than 10% of hematologic neoplasms, and 43% of malignant bone tumors. The disease is most commonly found in males over 60 years old. Tumor infiltration is associated with cytokine production inducing increased osteoclastic bone resorption and decreased or absent osteoblastic activity. This process results in accelerated and imbalanced osteolysis of the bone frequently resulting in pathologic fractures, severe bone pain, hypercalcemia, and compression of vertebral bodies that compromises both quality of life and survival expectancy.[1,2] Unfortunately, MM continues to be a severe life-threatening disease which is difficult to manage. Early detection and diagnosis of recurrent lesions are important for proper treatment and aids in prolonging survival rates.

Imaging plays a central role in the diagnosis, initial staging, follow-up, and restaging of patients with MM.[3] Plain radiography and computed tomography (CT) are established imaging techniques for MM evaluation. Whole body screening using plain X-ray is still used in most newly diagnosed cases of the disease. Its sensitivity is high in established lesions and is used primarily in the diagnosis of vertebral compression. CT also has high sensitivity but availability, radiation dosage, and high cost are some disadvantages of the technique. In dentistry, cone-beam computed tomography (CBCT) is emerging as an acceptable alternative to CT due to its high sensitivity and specificity in detection of bone alterations and should be considered when following cases that involve the head and neck region. This case report describes the potential application of CBCT in detecting oral bony lesions associated with MM or recurrent MM lesions.

CASE REPORT

A 75 year-old Caucasian male presented as a referral to the Tertiary Care Oral Medicine Clinic at the University of Texas Health Science Center at San Antonio (UTHSCSA) for evaluation of osteolytic lesions associated with the root of #11 detected on intraoral radiographic examination. The patient's medical history was significant for MM which was diagnosed in 2000. His symptoms at the time were episodes of back pain. The patient was treated with 4 cycles of chemotherapy (Mephalan and Interferon) and subsequent stem cell transplant. In 2001, Pamidronate Disodium and Zoledronic Acid were prescribed. He continued with Zoledronic Acid until 2006. At that time, his general dentist noticed exposed bone in the lower right quadrant, lingual to #30 and 31. The patient was referred to an oral surgeon for evaluation and treatment; the surgeon prescribed mouth rinses with Chlorhexidine and several months later there was healing of the region. Also during that time, the general dentist noted an endodontic lesion associated with #11 and root canal therapy was initiated. After treatment completion, the radiolucency on #11 persisted, prompting the referral to the oral medicine clinic at UTHSCSA.

At the time of our evaluation, the patient was taking Lenalidomide (10mg/day x 4 days), Enoxaparin (80mg), Dexamethasone (10mg/day x 5 days), Docusate, Acetaminophen, vitamins B, C, E, Zn and Folic Acid. The patient reported a previous history of melanoma, squamous and basal cell carcinomas of the skin, type 2 diabetes (when taking systemic steroids), and

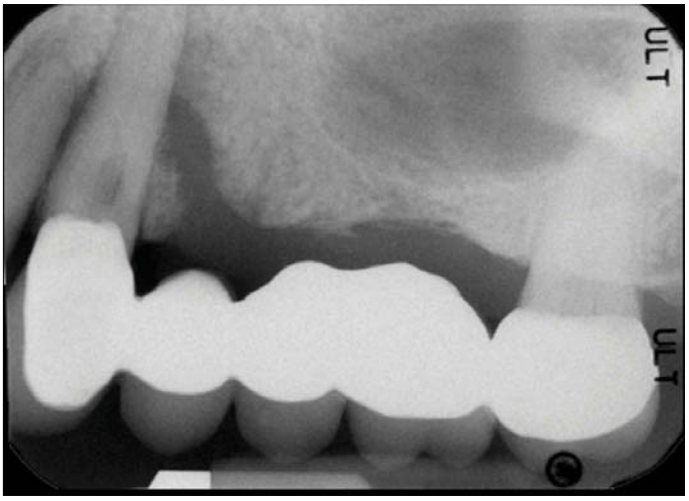

Figure 1: Intraoral radiograph showing severe vertical alveolar bone loss and presence of a detached small bone fragment on the distal aspect of the root of the left maxillary canine.

slightly impaired kidney function. Lungs, liver, and gastrointestinal tract functions were within normal limits. The patient's social history revealed occasional alcohol use and no smoking or recreational drugs use were mentioned.

Upon clinical extraoral examination, the patient presented with multiple areas of scarring from the removal of basal and squamous cell carcinomas and the melanoma. There were no temporomandibular joint symptoms, thyromegally, or lymphadenopathy. Intraorally, there was no evidence of exposed bone in the lower right quadrant. There was a 5-unit bridge extending from #11 to #15 and gingival recession extending from the middle of #10 to the distal of #11. The intraoral radiographs showed severe vertical alveolar bone loss and presence of a detached small bone fragment on the distal aspect of the root of #11 (figure 1). Due to the patient's medical history, MM involvement was suspected. In order to further evaluate the lesion, a CBCT was

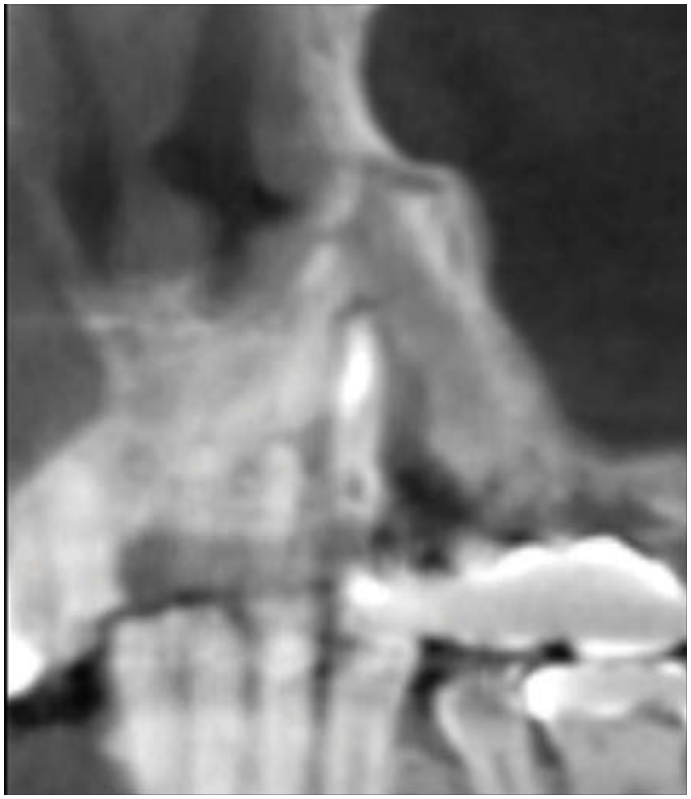

Figure 2: Cone Beam reconstructed image allowing visualization of the extension and characteristics of the bone loss in the left maxillary canine area.

acquired (AlphardTM Asahi Roentgen, Japan). The cone beam images viewed with the 3D OndemandTM software (Cybermed, South Korea) allowed visualization without structural superimposition; the extension and characteristics of the bone loss could be determined and a periodontal bone loss pattern rather than a myeloma associated lesion was diagnosed (figure 2).

The acquired CBCT provided information on structures outside of the field-of-view (FOV) and revealed other previously undiagnosed sites in the calvarium (figure 3). Upon detection of these new lesions, the patient was informed of the findings and then referred to his oncologist for re-staging and follow-up of the disease.

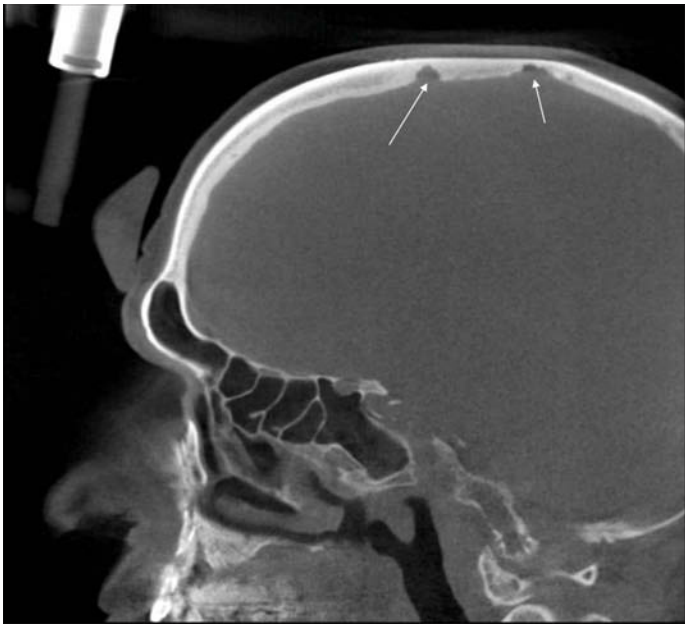

Figure 3: Sagittal view showing other previously undiagnosed multiple myeloma sites (arrows) in the calvarium.

DISCUSSION

Multiple myeloma is a malignant clonal neoplasm of plasma cells of B-lymphocyte origin that commonly results in overproduction of large amounts of monoclonal immunoglobulins. According to Gonzales et al (1991), in 12 to 15% of MM cases reviewed by these authors, oral and maxillofacial manifestations were the first sign of disease.[4] Common signs and symptoms include swelling, pain, mobility of teeth, bleeding, anaesthesia or paresthesia, pathological fracture, amyloid deposition, and soft tissue tumors.[5] Seventy to 80% of patients with MM manifest some kind of bone involvement characterized mainly by osteolytic lesions.[6] The multiple myeloma-induced osteolysis is a result of increased activity of osteoclasts adjacent to MM cells accompanied by suppressed osteoblastic differentiation and activity. Unlike osteolysis associated with other metastatic bone tumors, myeloma-associated lytic lesions are unique in that they do not repair even after many years of complete remission, reflecting a total loss of osteoblastic activity in areas of myeloma foci, apparently induced by the myeloma.[7]

Imaging plays an essential role in the assessment of skeletal involvement, detection of extramedullary diseases, and characterization of organ complications related to MM. Radiographic findings include "punched-out" radiolucencies without bone reaction, generalized osteoporosis, pathologic fractures and, occasionally, an osteosclerotic pattern.

Plain radiography is routinely used for skeletal surveys. Availability and low cost are some of the major advantages of conventional techniques. About 80% of patients with myeloma show radiographic evidence of skeletal involvement.[8] However, the sensitivity of plain films may not be sufficient to detect early osteolytic lesions and evidence shows that CT presents higher diagnostic accuracy than plain films allowing for more precise exploration, and better management of this disease.[9] Unfortunately, not all patients with MM have the proper access to advanced imaging modalities. D'Sa et al (2007) published an imaging guideline for cases of myeloma and questioned the utility of CT compared to plain films due to increased exposure to radiation and/or cost. The authors state that CT may not be practical as a screening tool; however it should be used to clarify the significance of ambiguous plain radiographic findings. CBCT may be a reasonable alternative in the head and neck region because it has the same ability to show early bone changes providing diagnostic images with lower radiation and cost in compar-

Table 1: Radiation effective doses to evaluate the maxillofacial region according to imaging modality	
Imaging Modality	**Effective Dose (E)**
Two direct digital	**0.0068 mSv**
Large FOV CBCT[11]	**0.042 to 0.806 mSv**
Computed tomography	**1.7 to 4.9 mSv**

ison with CT. Table 1 shows the necessary radiation effective dosage for each imaging modality applicable to evaluate the maxillofacial complex.

In the case presented here, CBCT was used to obtain more accurate information pertaining to the evaluation of the maxillary canine and supporting bone, as well as to access other structures of the head unattainable with conventional intraoral radiography. The images showed features characteristic of MM (bone defects and areas of osteoporosis) in places without any signs of symptoms reported by the patient, including the internal cortex of calvarium. CBCT images were useful to verify patient's current condition and presented several findings important and helpful in the medical management of the patient.

The purpose of imaging in the management of myeloma includes the assessment of the extent and severity of the disease at presentation, the identification and characterization of complications, and the assessment of response to therapy. Plain X-rays are routinely used for assessing dental and periodontal health; however, the compression into a two-dimensional image of a three-dimensional structure decreases both sensitivity and specificity of the exam. CT is able to provide images in multiple plains allowing the assessment of areas that cannot be accurately visualized by plain radiography, but high radiation dosage and cost have always been a concern for this technique.

CBCT is a growing imaging modality and has been used to image the hard tissues of the maxillofacial region. This system is able to provide more information than any other conventional dental imaging modality with high diagnostic quality in short scanning time, lower radiation dosage compared to medical CT, and the ability to identify manifestations of the disease providing a more thorough examination of the patient.

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Disclosure
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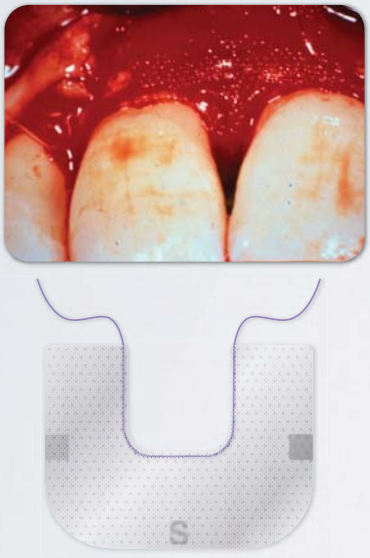

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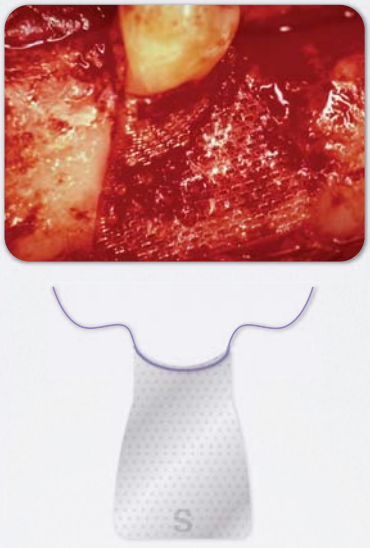

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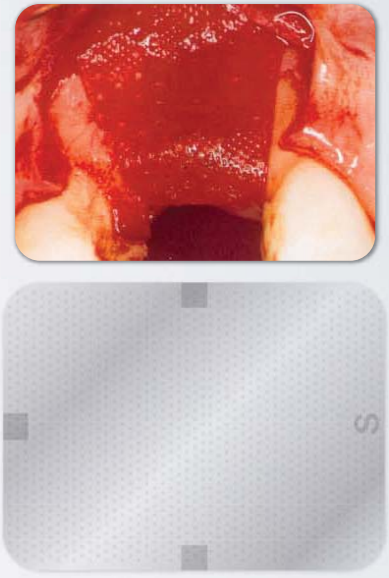
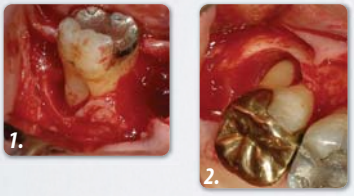
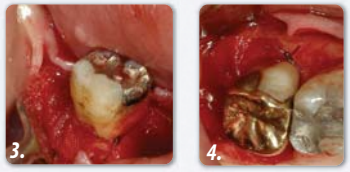


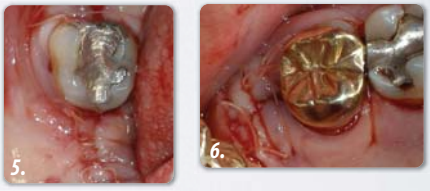
Case study by Dr. Gregory J. Conte, Periodontist, San Francisco, CA



Images 1-2: GUIDOR® Matrix Barrier to be placed on large circumferential osseous defects around maxilla right and mandible right second molars.



Images 3-4: Root surface modification and osseous distal around lower right second molar graft placed. The graft is covered and secured with a GUIDOR® wrap-around periodontal membrane. Suture allows for tight adaptation of the barrier membrane to the root surface.



Images 5-6: Flap adaptation and tension-free primary closure with interrupted Vicryl sutures.

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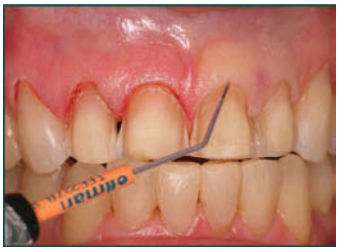
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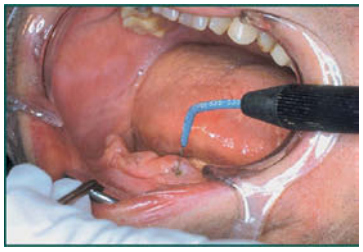
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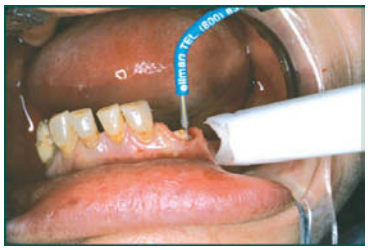
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Successful Treatment Using Dental Implants in Patients with Systemic Sclerosis: A Report on Two Cases

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Hiroyuki Tamaki, DDS, PhD[1] • Hiroyuki Okada, DDS, PhD[4]
Takao Kato, DDS, PhD[1] • Hirotsugu Yamamoto, DDS, PhD[4]

Abstract

Background: Systemic sclerosis (SSc) is a rare multisystem disease characterized by inflammation, vascular changes, and skin fibrosis. Orofacial abnormalities are frequently observed. Therapy for SSc patients is a challenge for dentists, as microstomia and xerostomia can make dental treatment complicated, while finger deformity due to sclerodactyly can make oral hygiene difficult for the patient. There are a few reports on implant treatment for SSc patients with fully edentulous jaws but none on implant placement for partially edentulous SSc patients.

Methods: We report on two limited cutaneous SSc patients treated with implant therapy for a partially edentulous jaw. A 66-year-old woman presented with loss of teeth #7 & 8, which had been extracted due to traumatic injury (Case 1). A localized ridge augmentation procedure was performed, and two implants were placed. A 65-year-old woman presented with loss of tooth #28, which had been extracted due to dental caries (Case 2). One implant was placed.

Results: There were no postoperative complications after the ridge augmentation procedure was performed by block bone grafting (Case 1), implant placement, and implant second-stage surgery, which demonstrated normal wound healing. Osseointegration was favorably maintained for 5 years (Case 1) and 1 year (Case 2).

Conclusions: The injurious effect on osseointegration between the bone and implant in SSc patients is poorly understood. However, the use of implants for these patients may allow them to maintain their natural dentition for a long period of time, thus preventing fully edentulism.

KEY WORDS: Scleroderma, CREST syndrome, dental implants

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INTRODUCTION

Systemic sclerosis (SSc) is a rare multisystem disease characterized by inflammation, vascular changes, and skin fibrosis which generally begins after midlife and is more frequently seen in women.[1] Although the cause of SSc is unknown, the involvement of vascular endothelial cell changes and immunologic mechanisms inducing fibroblast activation has been speculated.[2]

SSc is suspected when skin sclerosis, especially in the region ranging from the fingertips to the upper and lower arms, is observed. The diagnosis of SSc is made on the basis of a skin biopsy and clinical findings.[3] The histopathological findings of the disease show inflammatory and degenerative lesions in the connective tissues that are characterized by diffuse deposition of dense collagen.

SSc has two major variants, namely diffuse cutaneous SSc (DSSc) and limited cutaneous SSc (LSSc).[3] Anti-Scl 70 (anti-topoisomerase I) antibodies appear in 23-75% of DSSc patients, while anti-centromere antibodies are found in 43-80% of LSSc patients.[4] In DSSc patients, the skin sclerosis spreads to the trunk with visceral complications in the gastrointestinal tract, lungs, cardiovascular system and kidneys,[4] while in LSSc, the skin sclerosis remains localized in the fingers and face. Furthermore, LSSc progresses more slowly than DSSc and these affected patients have a better prognosis. Patients having calcinosis, Raynaud's phenomenon, esophageal stricture, sclerodactyly and telangiectasia possess the clinical features constituting the CREST syndrome.

In SSc patients, orofacial abnormalities are frequently observed as facial skin sclerosis causes a mask-like face and microstomia.[1,5-8] Most patients will have an interincisal distance of less than 40 mm on maximum opening.[6] The tongue becomes hard and rigid, making speaking and swallowing difficult. Xerostomia caused by fibrosis of the salivary gland or coexisting Sjögren's syndrome can induce a high incidence of dental caries and damage in the oral soft tissue. Telangiectasia of the oral mucosa is found in 56% of SSc patients,[6] and the loss of the attached gingiva and multiple areas of gingival recession may occur in some patients.[8] Furthermore, dental radiographic findings show a uniform widening of the periodontal ligament space in 10-37% of SSc patients[7] and bone resorption in the mandibular angle, the condyle, coronoid process, or the posterior border of the ascending ramus in some patients.[9]

Accordingly, therapy for SSc patients is challenging for dentists, as microstomia and xerostomia can make dental treatment difficult, and finger deformity due to sclerodactyly may make oral hygiene hard for the patients to manage. As a result, treatment with a fixed prosthesis can easily lead to dental caries, and a removable prosthesis may be uncomfortable for the patient, frequently making it impossible to continue using it. As a result of complications in dental treatment, many SSc patients are often fully edentulous.[10-17] There are few reports on implant treatment performed for fully edentulous SSc patients[13-17] and, to the best of our knowledge, none on implant placement performed for partially edentulous SSc patients. Implant treatment for these patients may allow them to maintain their natural dentition for a long period of time, which may prevent the jaw from becoming fully edentulous. In this report, we present the cases of two LSSc patients treated with implant therapy for a partially edentulous jaw.

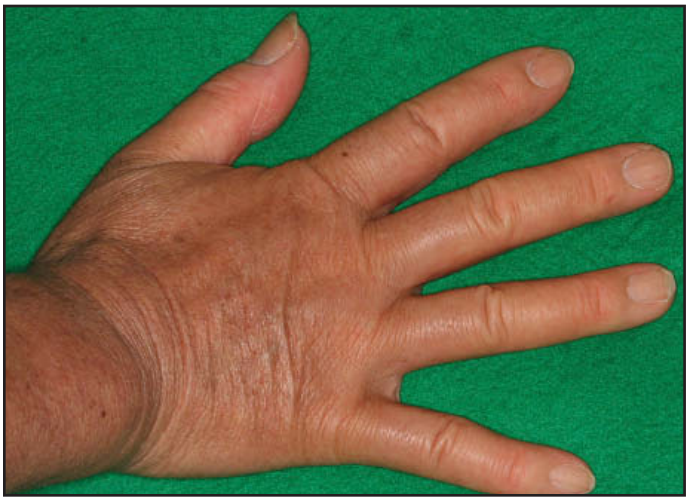

Figure 1: Sclerodactyly of the fingers in Case 1. A taut, shiny appearance of the skin is observed.

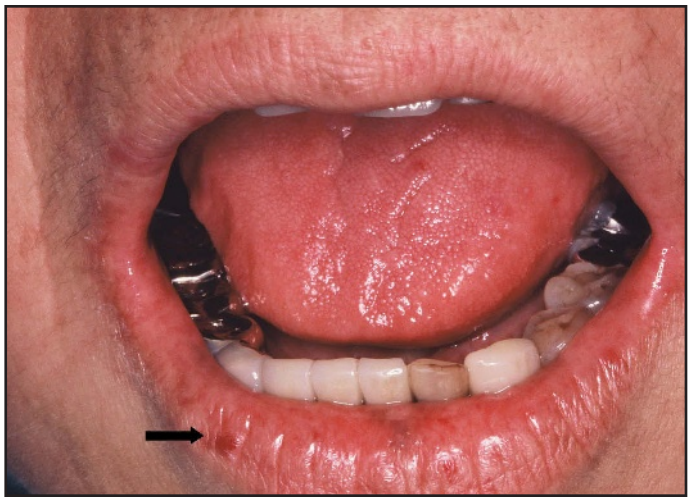

Figure 2: Limitation of mouth opening and telangiectasia of the lower lip (arrow) in Case 1. This photo demonstrates the patient's maximal opening because of the associated microstomia.

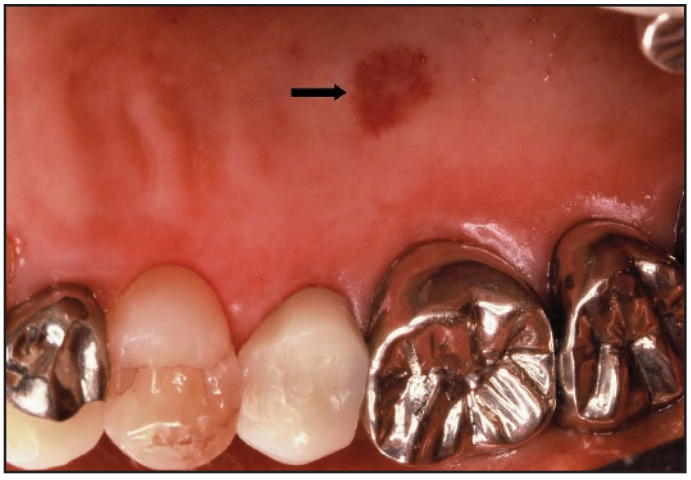

Figure 3: Telangiectasia of the palatal gingiva (arrow) in Case 1.

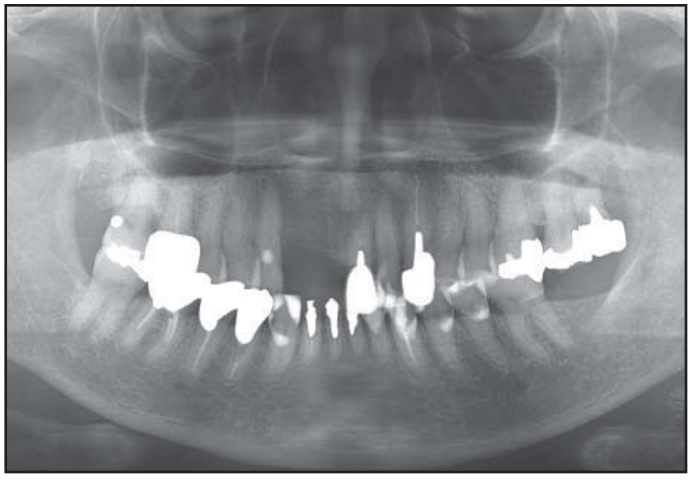

Figure 4: Panoramic radiograph before implant placement in Case 1.

CASE REPORT

Case 1

A 66-year-old woman was referred to us for implant therapy due to loss of teeth #'s 7 and 8 which had been extracted 1 year prior due to traumatic injury. Her case was complicated by Raynaud's phenomenon of the fingers for 10 years and she was diagnosed with LSSc by a rheumatologist. Sclerodactyly was observed upon physical examination (figure 1) along with skin sclerosis around the mouth (figure 2). We measured her mouth opening using the technique according to Nagy et al.[6], in which mouth opening of less than 40 mm is defined as "reduced." The maxi-

Figure 5: Localized deformity in an edentulous area of the anterior maxilla in Case 1 (mirror image). Occlusal view shows the extent of the bony ridge deformity.

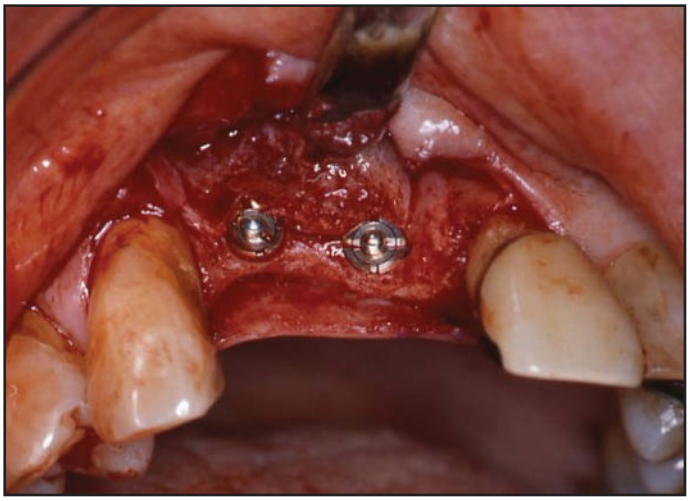

Figure 6: Implant insertion 6 months after ridge augmentation procedure in Case 1.

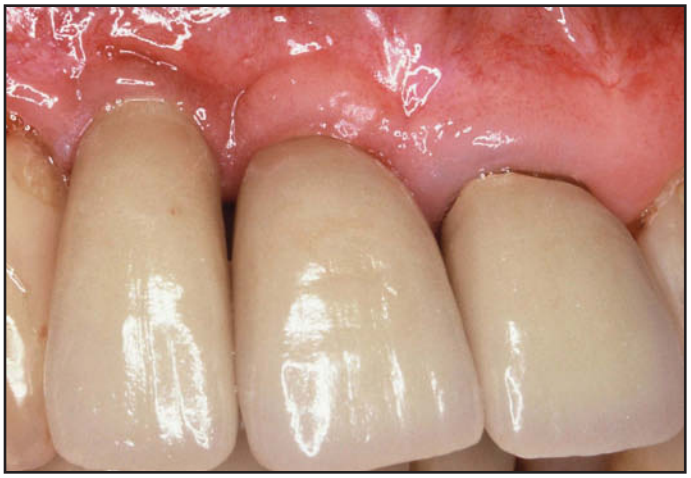

Figure 7a: Intraoral view 5 years after implant placement in Case 1.

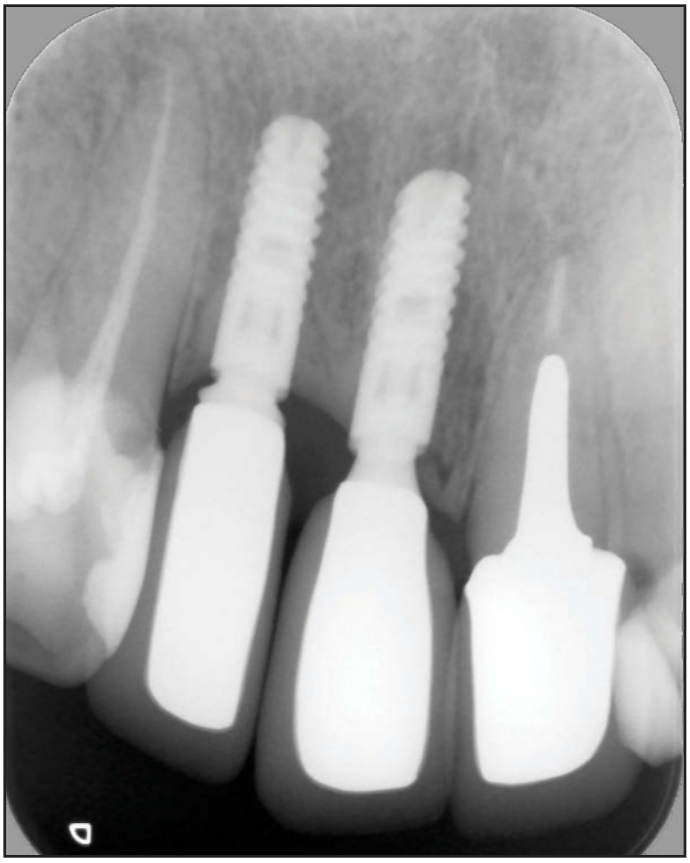

Figure 7b: Radiographic image 5 years after implant placement in Case 1.

mum mouth opening for this patient was 30 mm. In the oral mucosa, telangiectasia was observed in the lower lip, palatal gingiva, and mandibular facial gingiva (figures 2,3). She had 26 total teeth with teeth #'s 7 and 8 missing (figure 4). Mean probing depth was 2.5 mm and caries were not evident. Since she had been receiving periodic dental checkups, her oral hygiene was acceptable.

The patient did not smoke or take any medications.

The alveolar ridge where the anterior teeth were missing was rated as Class H (horizontal) I (large) according to HVC ridge deficiency classification[18] (figure 5). For the purpose of increasing the width of the alveolar ridge, a localized ridge augmentation procedure was performed prior to implant surgery. A block bone graft was collected from the chin, then positioned at the recipient site and retained with a bone screw under intravenous sedation with Midazolam. Six months after ridge augmentation, implant surgery was performed using a two-stage implant (Ankylos implant, DENTSPLY-Sankin K.K., Tokyo, Japan) under intravenous sedation with Midazolam. Two implants (3.5 mm diameter X 11 mm long) were placed (figure 6). Six months later a second-stage surgery was performed to fix the restoration. Periodic recall examinations were subsequently performed every 6 months. The radiographic findings 5 years later showed no peri-implant radiolucency and alveolar bone resorption was within a permissible limit (figure 7). There was no implant mobility suggesting that osseointegration was favorably maintained.

Case 2

A 65-year-old woman was referred to us for implant therapy due to the loss of tooth #28, which had been extracted 6 months prior due to dental caries. She had been diagnosed with LSSc by her physician 40 years before, then with type 2 diabetes mellitus and hypertension 15 years before, although the diseases had been favorably controlled. She was taking two medications (epalrestat and candesartan cilexetil) and she had no history of smoking. The mouth opening of this patient was 35 mm, demonstrating a mouth-opening reduction. Sclerodactyly was observed. There were no

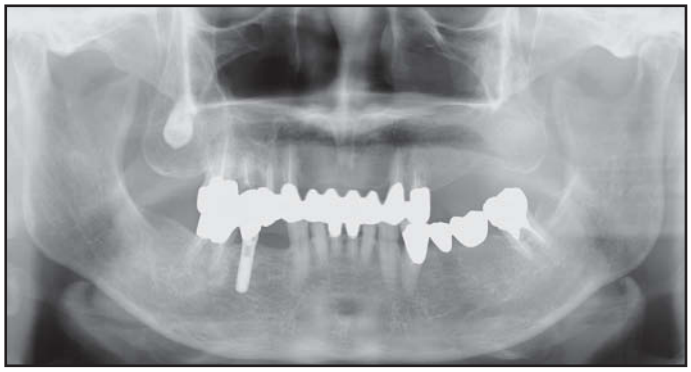

Figure 8: Panoramic radiograph before implant placement in Case 2. The implant in the right mandibular area had been placed 3 years prior. There was no implant mobility.

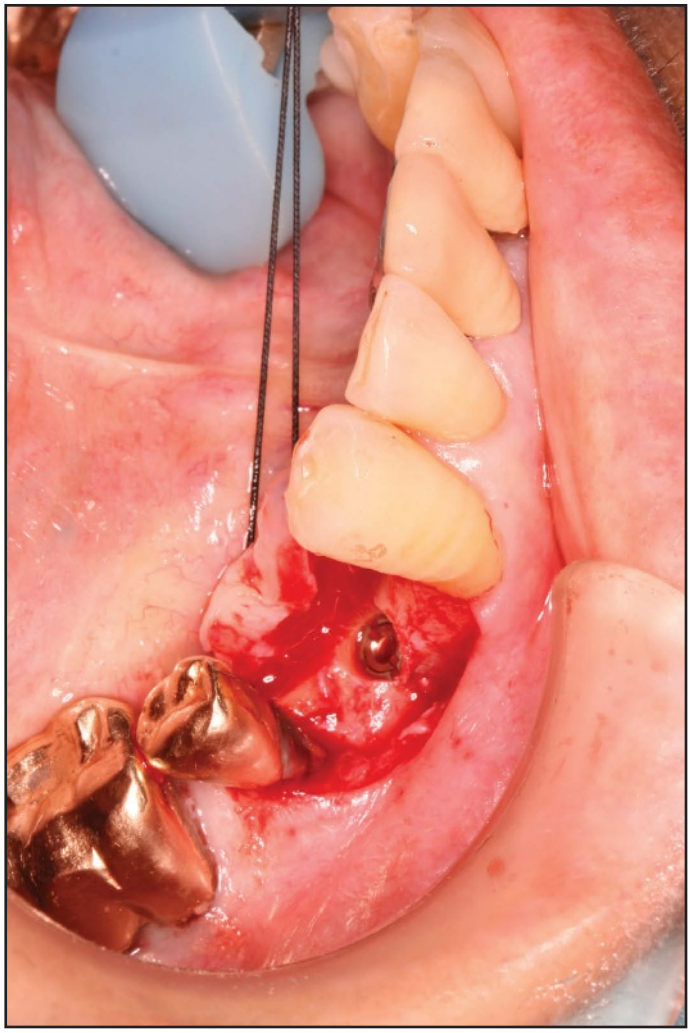

Figure 9: Implant insertion in Case 2.

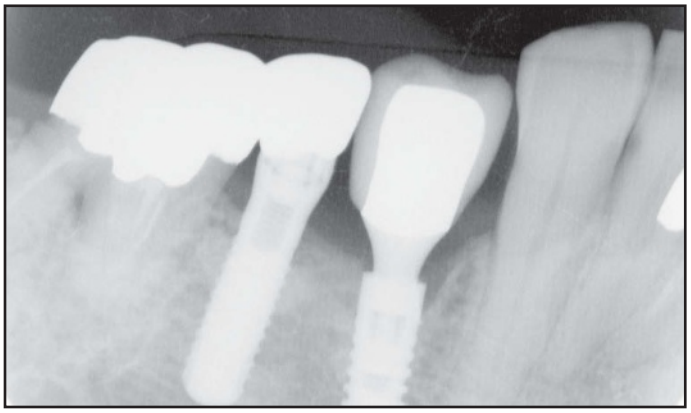

Figure 10: Radiographic findings 1 year after implant placement in Case 2.

changes found in the oral mucosa. She had 15 teeth and 1 implant, which had been placed for 3 years (figure 8). The mean probing depth was 2.4 mm. She had been receiving periodic dental checkups, thus her oral hygiene was acceptable.

For implant therapy, a two-stage implant (Ankylos implant, DENTSPLY-Sankin K.K., Tokyo, Japan) was used (3.5 mm diameter X 11 mm long), similar to that used in Case 1 (figure 9), although the second-stage surgery was performed 4 months after the first procedure to fix the restoration. Since the completion of this treatment, periodic recall examinations have been performed every 6 months. At the 1-year follow-up, the implant had clinically and radiographically osseointegrated (figure 10).

DISCUSSION

Implant failure can occur either as an early failure before and at about the time of abutment connection or as a later failure after implant loading.[19,20] An early failure is caused by inadequate osseointegration between the bone and implant. When bone healing is disturbed for some reason, and osseointegration between the bone and implant is impaired after implant placement, scar tissue is formed around the implant.[21] As a result, it can become mobile and bone resorption may follow.[19]

Implant therapy may sometimes be contraindicated in patients with metabolic diseases such as diabetes mellitus and osteoporosis, and in immunocompromised patients, as it is thought that normal osseointegration may be impaired in those patients. However, the level of evidence of the latter is relatively low.[22-25] Published case reports indicate that medically compromised patients such as those with Sjögren's syndrome,[26] severe lichen planus,[27] oral epidermolysis bullosa,[28] and Papillon-Lefevre syndrome[29] can be successfully treated with osseointegrated implants. However, implant therapy is likely contraindicated in patients with severe and acute medical conditions, and it is thought that the degree of disease control may be more important than the nature of the disease itself in regard to the effects on osseointegration. The two LSSc patients described in this report had no serious visceral lesion complications and relatively stable symptoms, which likely contributed to the success of implant therapy in these cases.

It is considered that anoxic tissue injury caused by prolonged vasospasms can lead to secondary fibrosis and scarring in SSc patients.[2,4] At the sites of anoxic injury, T-cells, macrophages, and platelets are activated and release a variety of cytokines that are involved in the proliferation and differentiation of mast cells and fibroblasts. It is speculated that in SSc patients, these processes are accelerated to form dense scar formation which results in hypofunction of the skin and other internal organs.[2,4] However, it is presently unknown whether or not pathologic changes in SSc patients may affect the osseointegration between the bone and implant or the wound healing of the bone.

There are 5 previous reports on implant ther-

apy performed for SSc patients, in which a total of 25 implants were placed.[13-17] Among them, only 1 implant (7-mm implant) was removed due to a failure of osseointegration.[17] There are also reports of reconstructive surgery for SSc patients, including corticocancellous grafting for treatment of osteomyelitis of the mandible[30] and surgical correction of secondary dysgnathia caused by SSc.[9] In both of those reported cases, normal wound healing of the bone occurred.

Stanford et al.[31] performed periodontal plastic surgery for a 38-year-old female with CREST syndrome and reported that the outcome of surgery was good without any surgical complications. They pointed out that telangiectasia was likely to cause excessive hemorrhaging in SSc patients and suggested considering the use of a surgical stent to deal with postoperative bleeding.[31] In Case 1 described in this report, telangiectasia was observed in the palatal gingiva, mandibular facial gingiva and lower lip, although none was found around the site of implant insertion. Moreover, there were no postoperative complications after the ridge augmentation procedure performed by block bone grafting, implant placement, and implant second-stage surgery, which demonstrated normal wound healing.

A later-stage implant failure may be caused by peri-implantitis associated with plaque-related infection or occlusal overloading.[19,20] There are contradicting reports regarding the susceptibility to periodontal infection in SSc patients. Wood & Lee[5] reported that 31 patients with SSc had significantly more periodontal disease than the control subjects, as reflected by the increased pocketing and gingivitis scores and tooth mobility. The authors believed that reduced vascularity and tissue ischemia might explain the increased susceptibility to periodontal disease.[5] In contrast, Nagy et al.[6] reported no significant differences in periodontal parameters including probing depth, gingivitis, plaque scores, and tooth mobility between 32 SSc patients and their matched healthy controls. In general, reduced mouth opening, tooth crowding and sclerodactyly often associated with SSc could interfere with effective oral hygiene and increase the risk for caries and periodontal disease. In the present study, the SSc patients had shallow mean probing depths and demonstrated no advanced chronic periodontitis. Furthermore, implant therapy was required for tooth loss due to traumatic injuries or dental caries, but not because of advanced periodontitis. Accordingly, in our patients, it cannot be said that the risk of peri-implant infection was high.

CONCLUSION

SSc patients are likely to be fully edentulous, and dental treatment is often difficult due to orofacial abnormalities. The injurious effect on osseointegration between the bone and implant in SSc patients is poorly understood, as there are no known reports on this subject. Nevertheless, implant therapy is likely to enhance the quality of life for SSc patients and may help them maintain long-term masticatory function.

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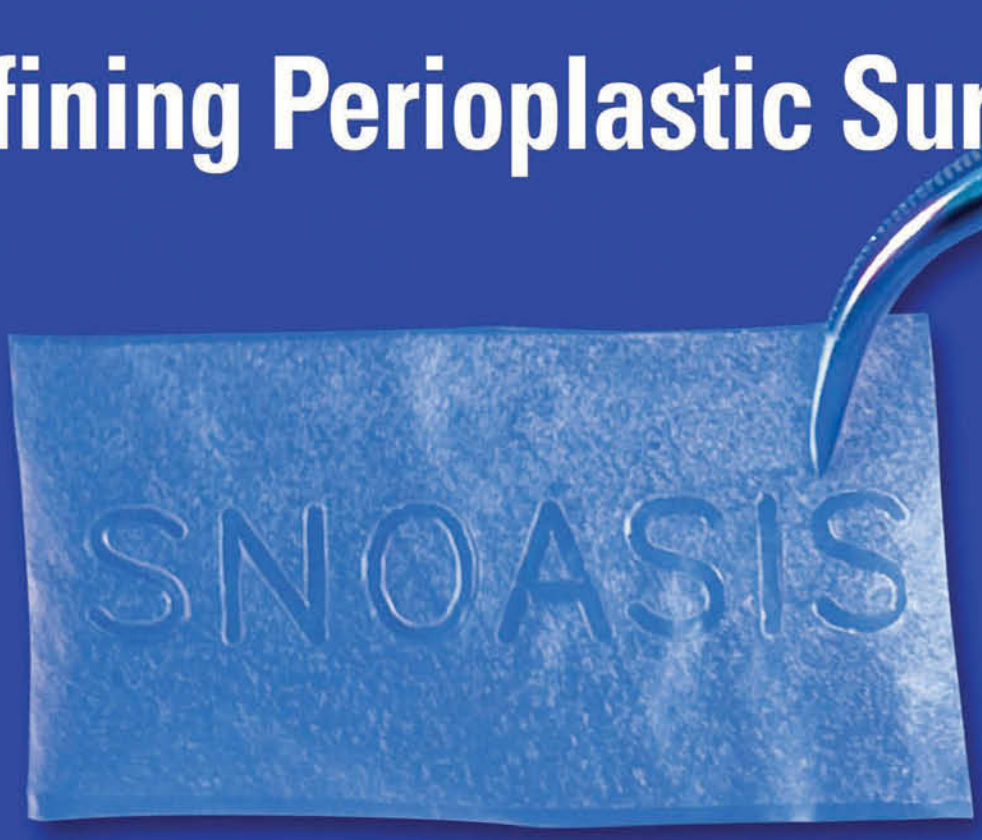

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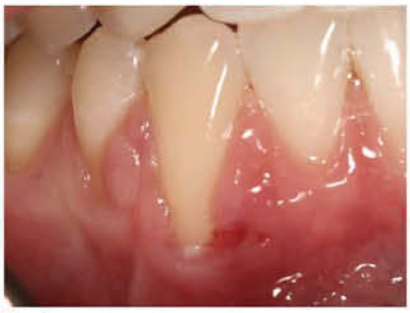
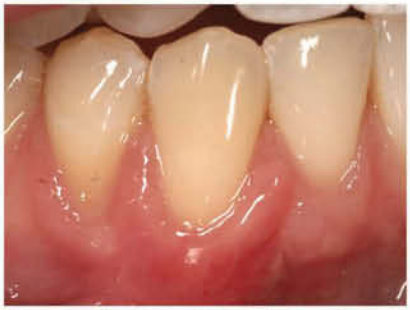


Before treatment



3 months post treatment

Case photographs courtesy of Dr. Brian Gurinsky, Denver, CO

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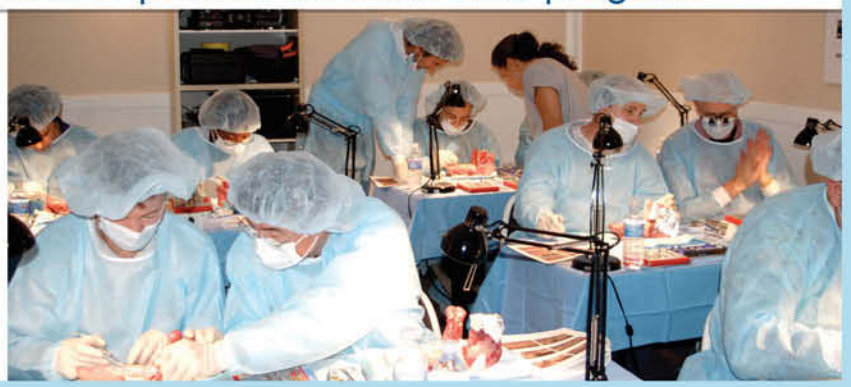

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Factors Driving Peri-implant Crestal Bone Loss - Literature Review and Discussion: Part 3

Mohammad Ketabi, DDS, MDS[1] • Robert Pilliar BASc, PhD[2]
Douglas Deporter, DDS, PhD[3]

Abstract

Many factors contribute to the cumulative crestal bone loss seen around endosseous dental implants. This can create confusion for the practicing clinician and lead to undesirable outcomes. In this four part review series, we have searched the literature for papers published in English language refereed journals for the decade preceding May 2008 and attempted to identify the major factors associated with peri-implant bone loss. Part three of this article series examines implant geometry, surface roughness, length, and diameter.

KEY WORDS: Crestal bone loss, dental implants, causative factors

Learning Objectives

After reading this article, the reader should be able to:

1. Discuss how implant geometry affects peri-implant crestal bone loss.
2. Discuss how implant neck design affects peri-implant crestal bone loss.
3. Discuss how implant surface roughness affects peri-implant crestal bone loss.
4. Discuss how implant length and diameter affects peri-implant crestal bone loss.

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INTRODUCTION

Many factors, both biological and biomechanical, will have a cumulative impact on the final amount of bone loss seen with dental implants. It is important for clinicians to understand all of these factors in addition to their relative contributions and interactions. This is the third installment of a four part series reviewing factors that drive peri-implant crestal bone loss. Part one of this review examined surgical and anatomical factors associated with peri-implant crestal bone loss. Part two reviewed patient and biologic width factors while, the current installment of this series examines implant geometry, surface roughness, length, and diameter.

MATERIALS AND METHODS

A literature search of papers published in refereed journals in the English language for the decade preceding May 2008 was performed by computer using the National Library of Medicine and SCOPUS Cochrane Oral Health Group databases. Search strategy included a specific series of terms and key words. The reference lists of identified publications, relevant textbooks and professional workshops also were scanned.

Relevant references were selected on the basis of their titles and abstracts. As the final selection method, full texts of publications identified as possibly relevant were reviewed for more detailed evaluation. Publications reviewed included experimental animal studies, prospective and retrospective human clinical studies, a few case reports and relevant review papers. Because of the limited numbers of available studies for some factors and their heterogeneity, focusing on a specific pre-defined question to be answered by a systematic review was not feasible and therefore no meta-analysis was attempted.

DISCUSSION

A number of dental implant related factors may contribute to peri-implant crestal bone loss. The most common of such factors include:

Implant geometry

Endosseous dental implants are essentially threaded screws made of titanium or one of its alloys (e.g. Ti-6Al-4V), although other implants such as plasma-sprayed surfaces press-fit cylinders and tapered truncated cones with porous surface zones formed by sintering Ti alloy powders also have been used.[1,2] Until recently, the majority of threaded implants had a cylindrical (i.e. parallel-sided) shape. However, recently popular tapered shapes that more closely resemble tooth roots have been suggested to provide more optimal stress transfer into crestal bone.[3] Following osseointegration, the bone-to-implant interface of most threaded implants comprises a planar contact without undercut regions. As a result, these transverse force components are transferred primarily as compressive forces to the crestal bone opposing the implant surface forced against it.[4-7] Additionally, the resulting stresses will be greatest in bone next to the most coronal implant thread tips. The resulting high localized compressive stresses can lead to micro-fractures in crestal bone followed by resorption. This coincides with the fact that most crestal bone loss with traditional threaded implants occurs in the first year of function.

Ways to reduce the high compressive forces acting on crestal bone with threaded implant designs would be to use longer implants, wider

implants,[8] specific thread pitch heights[9] (especially in cancellous bone)[9] tapered implant shapes, and micro-threads incorporated into the implant neck. Unlike most threaded implant designs, sintered porous-surfaced dental implants achieve integration by 3-dimensional bone ingrowth into and mechanical interlocking with the porous surface region formed by sintering. This type of bone-to-implant interface is able to provide resistance to interfacial tensile (upstream) forces. As a result, there is a more uniform stress distribution around the implant periphery with transverse force components being transferred to crestal bone at all implant aspects. This reduces the likelihood of micro-fracturing and resorption of crestal bone.[2,4,5]

Implant neck design

Traditionally, the cervical or "neck" region of dental implants had a non-threaded, highly polished surface of sufficient height to accommodate biologic width without exposing much of the threaded implant segment meant to maintain implant fixation. Polished collar heights were generally in the range of 0.75 to 2.8mm. Remembering that establishment of biologic width required at least 1.5mm of linear implant surface from the micro-gap, polished collar height became more important with rough and moderately rough implant surfaces which ideally should remain buried in bone to avoid complications like peri-implantitis.[10-13] Naturally, use of platform-switching to add a horizontal component to biologic width allows shorter polished collar regions to be used successfully. However, another effective way to manage the implant collar segment is to add micro-threads to its geometry.

Micro-threads offer two possible advantages. Firstly, their addition increases linear length of coronal implant surface available for biologic width and allows some stress transfer in the coronal region superior to the macro-threaded segment of implant body.[14] This lower level of stress transfer to crestal bone is less likely to cause bone micro-fractures and reduces the probability for stress-shielding and disuse atrophy of crestal bone as may occur with traditional polished implant collars. Both clinical[15-18] and animal[19] studies have documented good retention of crestal bone for implants with incorporated micro-threads. In some studies, bone loss associated with coronally incorporated microthreads ranges from 0.11-0.18mm over 1 to 5 years.[18,20,21] Finite element studies[22] have suggested that creating laser micromachined grooves (8 to 12 μm wide) to the lower part of a polished collar segment may reduce crestal bone loss in a manner similar to micro-threads (i.e. by altering strains in crestal bone) but, this possibility requires further study.

At present, few implant designs incorporate micro-threads. Rather, there has been a move to shorten or eliminate polished collar segments, with manufacturers electing to have implant collars with moderately rough surfaces in the hope of stimulating crestal bone with low levels of stress transfer as is thought to occur with micro-threads. This has not always been a successful approach as multiple studies have demonstrated increased crestal bone loss secondary to microbial colonization of exposed roughened collars.[12,23-26]

While carrying a moderately rough texture all the way to the top of an implant has not been adequately confirmed to be beneficial, hav-

ing a polished collar that is too long also may lead to unwanted bone loss. Al-Sayyed et al[27] studied crestal bone loss in dogs around 2-piece, sintered porous-surfaced implants with either short (0.75mm) or long (1.8mm) collars. The short collared implants showed less bone loss, and the difference from long collared implants was linked to 'stress-shielding' of crestal bone and disuse atrophy.[28-30] When histological preparations of retrieved specimens from Al-Sayyed's dog study were examined, the data suggested that the primary driving force in crestal loss seen was biologic width accommodation, not stress-shielding. Additional studies[31,32] support the findings that the effect of stress-shielding with unnecessarily long polished collars is of relevance after biologic width accommodation has had its effect.

Implant surface roughness

Implant surface roughness may be classified as minimally rough, moderately rough, or rough. Machine-turned implant surfaces, as used on the original Branemark-system® threaded implant, are considered to be minimally rough (Sa - 0.5µm) while, only plasma-sprayed surfaces, like those used on the original Straumann ITI implant[33] or titanium plasma-sprayed press-fit implants,[34] are classified as rough(Sa > 2.0 µm). The majority of contemporary threaded implant designs have what are considered to be moderately rough surfaces (Sa between 1.0 - 2.0 µm). Moderately rough implant surfaces have been shown to be more osteoconductive than minimally rough ones[35] and, as a consequence, require shorter initial healing intervals.[36,37] Employing a moderately rough surface increases resistance to torquing (i.e. horizontal shear) forces once integration has developed[38,39] and may be one approach to improving implant outcomes in bone of lower density even with abbreviated healing intervals.[40]

Direct clinical comparisons of minimally rough (machine-turned) and rough (plasma-sprayed) threaded implants certainly have shown that the latter cause greater crestal bone loss and implant loss.[10,11] However, data does not exist on whether incorporating features like minimally rough micro-threads in the collar region and platform-switching might make outcomes with rough surfaced implants more favorable. Certainly, rough surfaces on deeper threads could be of benefit as they provide highly irregular surfaces with undercut features that may allow sufficient mechanical interlock of bone to improve resistance to interfacial tensile forces associated with off-axis loading, at least compared to minimally and moderately rough surfaces.[4]

Direct clinical comparisons of minimally rough and moderately rough threaded implants have been accomplished. In multiple studies with long term follow-up intervals, moderately rough dental implant surfaces repeatedly demonstrated less crestal bone loss and higher survival rates in comparison to minimally rough implants.[26,41-43]

Rocci and colleagues[44] compared anodized with machine-turned threaded implants that all were immediately loaded in posterior mandible locations. Implant failure rates were 14.5% for machine-turned and 4.5% for surface anodized implants. Mean marginal bone loss after 1 year of loading was similar (0.9 mm for surface anodized vs 1mm for machine-turned). Aalam et al[12] provided bone loss data for implants with surfaces roughened by anodization or dual acid-etching compared to machine-turned implants

at two years post-loading. No significant differences were seen but, a trend toward greater bone loss was seen with anodized implants which, as discussed earlier, unlike the other two implant types, had no polished collar. In contrast, Watzak et al[62] reported significantly (P=.03) less marginal bone loss (1.17mm vs. 1.42mm) with anodized compared to machine-turned surfaces both of which had 1mm polished collars. These implants had been placed in the intra-foraminal region of edentulous mandibles and used to support overdentures during a mean functional period of 33 months.

Implant length and diameter

Both length and diameter (width) of dental implants may influence marginal bone loss. Naert et al[25] evaluated factors influencing marginal loss with machine-turned threaded implants functioning in partially edentulous patients for as long as 15 years. After 6 months in function, significantly (P=.03) more bone loss was observed as implant length increased. Implants in lengths of 7mm, 13mm, and 18mm had annual bone loss of 0.02mm, 0.04mm and 0.05mm respectively. It was suggested that longer implants lost more crestal bone because they were more likely to have been placed in sites of predominantly alveolar rather than basal bone, the latter being more resilient to resorption. However, other identified factors may have played a role in this rather surprising outcome. Rokni et al[45] reported a similar negative correlation between crestal bone loss and implant length with sintered porous-surfaced, press-fit implants after 5 years function. Long implants (9 or 12mm) had significantly greater crestal bone loss (0.2 mm more) than short implants (5 or 7mm). Others, however, have found that short threaded implants suffer more crestal bone loss than longer ones. Chung et al[46] presented retrospective findings in 69 patients for 339 implants with various surface roughnesses. After an average of 8.1 years, implant length had a significant ($P < .05$) impact on bone loss with implants < 10mm in length showing greater bone loss (0.19mm vs 0.12mm) than those with lengths ≥10mm.

Like implant length, differing implant diameters have been associated with crestal bone loss. Multiple studies have demonstrated that increased implant diameter tends to be associated with reduced crestal bone loss.[47-50] Studies[47,48] using 3-dimensional finite element model analyses suggested a likely correlation between implant diameter and crestal bone loss with maximum stresses occuring around the implant neck and these stresses are likely to be reduced by increasing implant diameter. The greatest effect (31.5% reduction in stress) was found for increasing diameters from 3.6 to 4.2 mm. Moving to a 5.0mm diameter implant reduced stress by a lesser amount (16.4%).

CONCLUSIONS

Implant geometry will affect the type of bone-to-implant surface interface that is responsible for osseointegration. Most threaded implants achieve integration by planar bone-to-implant surface contact and this does not provide resistance to off-axis tensile forces. As a result, excessive compressive stresses can develop in bone abutting the tips of threads and lead to micro-fractures in crestal bone. Sintered porous-surfaced press-fit implants achieve integration by 3-dimensional interdigitation through bone ingrowth resulting in more uniform stress transfer and reduced likelihood of crestal bone micro-fractures and resorp-

tion. With threaded implants, ways to reduce high crestal stress concentration include using tapered rather than cylindrical implant shapes and/or incorporating micro-threads into the collar region of the implant body. These smaller threads are thought to promote more physiological crestal stresses resulting in crestal bone retention rather than resorption, as well as reducing peak stresses more apically (next to macro-threaded implant regions). In the absence of micro-threads and/or platform-switching, it is advisable that all dental implants have a short (e.g. 1 to 1.5mm) polished collar segment to allow for successful accommodation of biologic width without exposure of moderately rough or rough implant surfaces. Carrying these rough surfaces to the top of an implant body may in some situations increase the risk of excessive crestal bone loss and other complications.

The biggest impact of giving threaded implants a moderately rough texture is improvement in surface osteoconductivity and shortening of initial healing intervals. These surfaces do not appear to increase resistance to off-axis tensile forces. Because of the added surface area, however, moderately rough threaded implants often do appear to perform better than machined turned implants in bone of low density unless modified surgical procedures are employed to improve initial implant stability.[50]

Finally, both implant length and diameter may affect crestal bone loss at least with some implant designs. Press-fit, sintered porous-surfaced implants for example show significantly less crestal bone loss in lengths of 5 or 7mm as opposed to lengths of 9 and 12mm. With threaded implant designs, study outcomes on the effects of implant length differ. Some investigators have reported greater crestal resorption as implant length increases and some the reverse relationship. Animal and finite element analysis studies have suggested that as implant diameter increases crestal bone micro-fractures and resorption should decrease.

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Disclosure
The authors report no conflicts of interest with anything mentioned in this article.

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Continuing Education JIACD Quiz #5

1. Most crestal bone loss associated with dental implants happens when?
- **a.** Within first year of function
- **b.** Between years 2-3 of function
- **c.** Between years 3-5 of function
- **d.** After 10 years of function

2. Ways to reduce compressive forces acting on crestal bone include:
- **a.** Using longer implants
- **b.** Using wider implants
- **c.** Using tapered implant shapes
- **d.** All of the above

3. To avoid complications such as peri-implantitis, roughened implant surfaces should ideally remain buried in bone.
- **a.** True
- **b.** False

4. What advantages are offered by a micro-threaded collar design?
- **a.** Increase linear length of coronal implant surface available for biologic width
- **b.** Allows stress transfer in the apical region superior to the macro-threaded segment of implant body
- **c.** There are no advantages offered by micro-threads
- **d.** All of the above

5. Over one to five years, what is the range of bone loss associated with coronal micro-threads?
- **a.** 0.11 – 0.18mm
- **b.** 0.25 – 0.50mm
- **c.** 0.51 – 0.76mm
- **d.** 1.09 – 1.6mm

6. Implant surface roughness may be classified as:
- **a.** Minimally rough
- **b.** Moderately rough
- **c.** Rough
- **d.** All of the above

7. The majority of contemporary threaded implant designs have what type of surface?
- **a.** Minimally rough
- **b.** Moderately rough
- **c.** Rough
- **d.** Smooth

8. Moderately rough implant surfaces have been shown to be more osteoconductive than minimally rough implant surfaces.
- **a.** True
- **b.** False

9. In multiple studies with long term follow-up intervals, which implant surfaces repeatedly demonstrated less crestal bone loss and higher survival rates?
- **a.** Smooth
- **b.** Minimally rough
- **c.** Moderately rough
- **d.** Rough

10. 3D finite element models suggest that maximum stress occurs at what portion of the implant?
- **a.** Implant neck
- **b.** Implant body
- **c.** Implant apex
- **d.** Stresses are uniformly distributed

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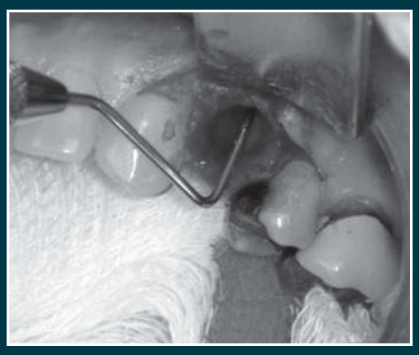

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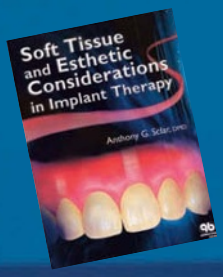

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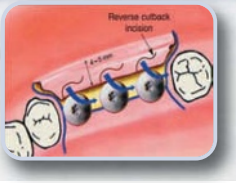


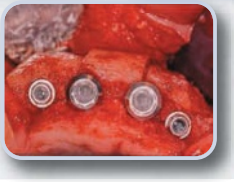

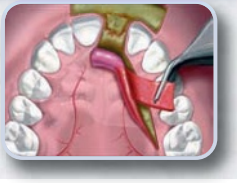

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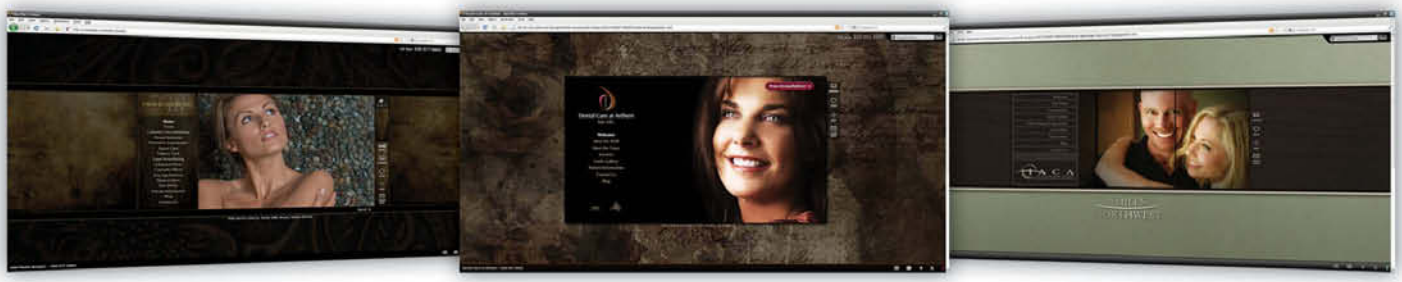

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*The Harvest Technologies PRP Separation System is designed o be used for the safe and rapid preparation of autologous platelet-rich-plasma (PRP) from a small amount of blood at the patient's point of care. The PRP can be mixed with autograft and allograft bone prior to application to an orthopedic surgical site as deemed necessary by the clinical use requirements.

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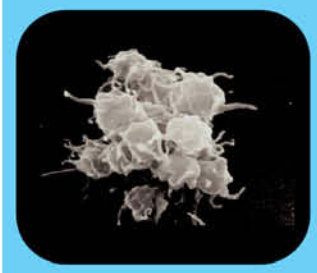


Platelet Yield

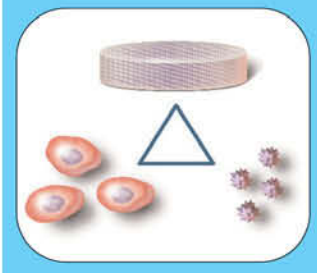
The SmartPReP 2 patented floating shelf technology optimally separates biological cellular components; producing platelet yields 4-6x above baseline levels.

Technologist Time

The SmartPReP 2 produces autologous platelet concentrate in a fraction of the time as other systems; requires only 2-3 minutes hands-on technologist time.

Sterile Barrier Entries

The SmartPReP 2 has the fewest sterility breaks of any system; this decreases the risk for mistakes or contamination.



Growth Factors

The SmartPReP 2 produces consistent levels of platelet concentrate with 7 growth factors, fibrin, fibronectin and vitronectin.

FDA Cleared

The SmartPReP has been in use for over 8 years in US for the preparation of autologous PRP. Is your machine's PRP cleared for human use?

For copies of the test results on Harvest SmartPReP 2 compared to other PRP system done by the Center for Blood Research at Harvard email kjames@harvesttech.com

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