Atraumatic Extraction of Multi-Rooted Teeth

Site Preservation with Bioactive Calcium-Phosphosilicate Grafts
Introducing

Mucograft®
collagen matrix

Mucograft® is a pure and highly biocompatible porcine collagen matrix. The spongy nature of Mucograft® favors early vascularization and integration of the soft tissues. It degrades naturally, without device related inflammation for optimal soft tissue regeneration. Mucograft® collagen matrix provides many clinical benefits:

For your patients...

→ Patients treated with Mucograft® require 5x less Ibuprofen than those treated with a connective tissue graft

→ Patients treated with Mucograft® are equally satisfied with esthetic outcomes when compared to connective tissue grafts

For you...

→ Surgical procedures with Mucograft® are 16 minutes shorter in duration on average when compared to those involving connective tissue grafts

→ Mucograft® is an effective alternative to autologous grafts, is ready to use and does not require several minutes of washing prior to surgery

Ask about our limited time, introductory special!

Mucograft® is indicated for guided tissue regeneration procedures in periodontal and recession defects, alveolar ridge reconstruction for prosthetic treatment, localized ridge augmentation for later implantation and covering of implants placed in immediate or delayed extraction sockets. For full prescribing information, visit www.osteohealth.com


Less pain for your patients.¹
Less chair side time for you.¹
Familiar Confidence.
The infinity System allows you to place our implants with the familiar confidence you get from your existing system.

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You will notice one difference with the infinity Implant...pricing. We are committed to delivering a compatible implant at pricing that creates significant opportunities for both you and your patients.

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Our NuOss Family Is EXPANDING!

EXPANDABLE BONE GRAFTING COMPOSITE

NuOssXC™ the latest development in natural bone substitutes:
• Supports bone growth in periodontal and oral maxillofacial defects.
• Is a composite grafting material comprised of mineralized de-proteinated bovine granules and purified type I bovine collagen.
• When placed into a bleeding site, the material expands to a predetermined size and shape.
• Available in sinus form and socket form, which is supplied pre-loaded in a delivery syringe.

Features and Benefits:
• Expanding composite material allows for placement in a compressed form with self-expansion to fill the entire defect upon hydration.
• Simple implantation technique.
• Composite nature of the material enhances graft stability and minimizes particulate migration.
• Optimizes spacing between particulate to allow for bone ingrowth.

Expansion time:
Immediately upon contact with blood source or by hydration with sterile saline after implantation.
Introducing the Laser-Lok® 3.0 implant

Laser-Lok 3.0 is the first 3mm implant that incorporates Laser-Lok technology to create a biologic seal and maintain crestal bone on the implant collar. Designed specifically for limited spaces in the esthetic zone, the Laser-Lok 3.0 comes with a broad array of prosthetic options making it the perfect choice for high profile cases.

- Two-piece 3mm design offers restorative flexibility in narrow spaces
- Implant design is more than 20% stronger than competitor implant
- 3mm threadform shown to be effective when immediately loaded
- Laser-Lok microchannels create a physical connective tissue attachment (unlike Sharpey fibers)

For more information, contact BioHorizons
Customer Care: 888.246.8338 or
shop online at www.biohorizons.com
Osteogenics
Pick up Flash file from October issue
page 1
INNOVATION

MIS offers a wide range of innovative kits and accessories that provide creative and simple solutions for the varied challenges encountered in implant dentistry. To learn more about MIS visit our website: misimplants.com or call us: 866-797-1333 (toll-free)

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Purchase any MIS implants in multiples of 5 (minimum 10 implants) and receive one free CPK - Complete Prosthetic Kit, with each implant.

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Case courtesy of Dr. Mariano Polack and Dr. Joseph Arzadon, Gainesville, VA
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**HEALOS® is an attractive choice for building new bone.**

HEALOS® Bone Graft Substitute for Dental Applications is intended to fill, augment, or reconstruct periodontal and/or bony defects in the upper or lower jaw.

- Excellent clinical handling properties
- Provides an osteoconductive scaffold that supports cell adhesion
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Come on, seriously? We are professionals here. Why do we feel the need to hawk our services like street peddlers? Do you see cardiac surgeons advertising (Loud booming voice) “This month Dr. Jones is offering coronary artery bypass surgery for only $995! (small, fast speaking voice...offer valid while supplies last, anesthesia, monitoring, and hospital stay not included). No, we do not see anything like this. Why is this so? My best guess is insurance.

In the United States, there is a huge disparity between medical and dental insurance. To be frank, dental insurance in the United States is downright pathetic. US dental insurance policies have teeny tiny monetary caps. By the time most patients get one procedure done, especially if you are talking about an implant related procedure, they have used up their dental benefits for the year. Unfortunately, once patients hit their cap, they must pay for the remainder of their treatment out of pocket. This is why many patients put off dental treatment. There are simply too much out of pocket costs. Compare this to medical insurance which will pay thousands of dollars for something as innocuous as removal of an ingrown toenail, and it is easy to see why patients in the United States have a much easier time getting medical treatment than dental treatment. If dental insurance paid for treatment comparably to medical insurance, the level of dental treatment in the United States would skyrocket.

This is why we see so much dental advertising in the US, especially for dental implant or surgical treatment. The out of pocket expenses are simply too high and dental treatment becomes discretionary in many cases. We must advertise to attract the patients that can afford the out of pocket costs. This is also a reason why I think dentists in the US get little respect in comparison to physicians. If we were “real doctors” like physicians, we would act like physicians and not advertise.

If medical insurance was as bad as dental insurance, we would see a lot more medical advertising, not to mention a lot of very sick people roaming the streets. People simply could not afford the out of pocket expenses for most medical treatment in the US without huge medical insurance payouts. $200,000 for an open heart surgical procedures with all of the trimmings? No problem...your medical insurance will pay for it. $4,000 for a tooth extraction, bone graft, dental implant, and crown? Whoa, whoa, whoa there fella...we (dental insurance) are not going to pay all of that! We will cover $1,000. You are on your own for the rest.

*Offer Valid While Supplies Last

Dan Holtzclaw, DDS, MS
Founder, Co-Editor-In-Chief

Nick Toscano, DDS, MS
Founder, Co-Editor-In-Chief
GUIDOR® Bioresorbable Matrix Barrier

Barrier function is maintained for 6 weeks after surgery and gradually degrades until the matrix is fully absorbed in 6 to 12 months.

Indications
The use of GUIDOR to aid in bone regeneration and augmentation should be limited to defects and concavities within skeletal contours and to defects/situations where moderate increase of bone volume beyond the skeletal contours is desirable. In all cases, appropriate space making support should be used.

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GUIDOR is contraindicated in those situations where general periodontal surgery should not be performed. Currently there are no known additional contraindications to the use of GUIDOR.

For Excellent predictability and ease of use in GBR

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GUIDOR is not intended for use in cases other than those described under indications and has not been clinically tested in patients with extra large defects, for extensive bone augmentation, or for use in the treatment of failing implants.

GUIDOR has not been clinically tested in pregnant women or in immunocompromised patients (patients with diabetes, HIV, undergoing chemotherapy or irradiation).

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Possible complications following any oral surgery include thermal sensitivity, flap sloughing, some loss of crestal bone height, abscess formation, infection, pain, and complications associated with the use of anesthesia; the patient may experience minor discomfort for a few days.

GUIDOR® has a double layered matrix with two uniquely perforated layers:

The two layers are separated by inner spacers (1) to form an interspace (2) into which tissues can grow.

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Designed to Stimulate the Healing Process

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- The signaling proteins (growth factors, glycoproteins, glycosaminoglycans) communicate with the body to help stimulate the natural healing process.

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- Accell has nearly 5 times more BMPs than DBM alone and each lot is validated for osteoinductive properties.
- Accell is delivered as an easy-to-handle putty in a pre-filled syringe.
- Accell is the only allograft product that contains this powerful combination of DBM, BMPs and Growth Factors.

4. Amounts of BMP-2, BMP-4, BMP-7 and TGF-81 contained in DBM particles and DBM extract. Kay, JF; Khaliq, SK; King, E; Murray, SS; Brochmann, EJl. Isotis Orthobiologics, Irvine, CA (white paper/abstract).
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Background: Long-term success of dental implants has been demonstrated when placed simultaneously with or after a socket grafting procedure. Although optimal bone formation can be from 6 to 9 months or longer with grafting materials other than autogenous bone, utilization of bone allograft eliminates patient morbidity through elimination of autograft harvest sites.

Methods: This study evaluated bone formation following grafting of 22 post-extraction alveolar sockets with bioactive calcium phosphosilicate putty (CPS Putty) graft material.

Results: At 5-6 months post grafting there was bone regeneration showing both normal clinical attributes and radiographic trabecular appearance. Histomorphometric analysis revealed average vital bone content of 48.2% ± 6.8 to residual graft content of 2.4% ± 1.4 for the 22 sockets in the study, at an average healing period of 5.4 months ± 1.5.

Conclusions: The high percentage of vital bone content, after a relatively short healing phase, suggests that CPS Putty can be a reliable choice for osseous regeneration in cases of crest preservation and implant related surgeries.

KEY WORDS: Site preservation, bone graft, allograft, extraction, dental implants

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INTRODUCTION
Extractions occur primarily as a result of periodontal disease, caries or trauma. Caries is endemic and a leading cause of tooth loss in the US population. Periodontal disease is responsible for 30-35% of extractions in people over 40 years of age. Clinically it is important to replace missing teeth with the most suitable option for the patient, so that ridge and site preservation at the time of extraction is critical to long term success, irrespective of the procedure used for tooth replacement.

Autogenous bone has been considered the “gold standard” for filling bony defects, especially large defects resulting from cysts and tumors, alveolar resorption, and periodontal bony defects, all of which leave insufficient bone for the placement of implants. The cancellous portion is usually used and it is rich in mesenchymal cells, which are generally involved in osteogenesis. However, clinical situations, such as the size of the bony defect, absence of enough donor tissue, or the need for a second intervention, may preclude its use.

The ongoing development of biomaterials has improved the characteristics and properties of potential synthetic bony substitutes. The challenge has been to assess the interface between the biomaterial and the host. Alloplastic bioactive graft substitutes are a potential advance in solving this issue. A bioactive material is defined as one that will create a biological response that will prevent a fibrous repair at the interface, but rather lead to a bony union of the material and the host tissue. Bioactive glass ceramics have demonstrated such biocompatibility and direct contact with bone. The first bioactive material was reported in 1971. It was a four-component oxide mixture, consisting of 45% silica dioxide, 24.5% sodium, 24.5% calcium and 6% phosphorous. This product has evolved and is now being marketed as a pre-mixed, moldable material called NovaBone Dental Putty® (US Biomaterials Corp., Alachua, Fla.) consisting of four components: two bioactive phase components—a 55% standard calcium phosphosilicate (CPS) particulate, and a 14% CPS smaller particulate—as well as a 12% polyethylene glycol additive phase and a 19% glycerin binder phase. In dentistry this latter putty form of calcium phosphosilicate is designed for osseous regeneration of periodontal bone defects, filling of alveolar sockets, sinuses and augmentation of alveolar ridges.

The purpose of this study was to clinically, radiographically and histologically evaluate CPS Putty when used as a bone graft material in human alveolar post-extraction sockets.

MATERIALS AND METHODS

Material
Bioactivity is initiated immediately upon implantation. The smaller CPS particles release calcium and phosphorous ions into the area, the binder material gets absorbed over a period of a week exposing the larger CPS particulates to blood. Breaking the silicon-oxygen bonds releases silicic acid, which forms a negatively charged gel at the particle surface. In several hours calcium phosphate is produced in the gel, which then crystallizes into a new surface apatite layer. Bioactivity begins in this surface layer when collagen, glycoproteins and mucopolysaccharides from the surrounding bone are incorporated into the apatite layer. This helps to produce a direct chemical bond with the host bone. In vivo, the graft substitute bonds to connective tissues and to bone. The apatite layer helps in the stimulation of osteoprogeni-
tor cells to produce transforming growth factor, by the release of silicon from the surface.\textsuperscript{3,9-12}

**Methods**

There were 22 patients (14 males and 8 females), between the ages of 25 and 79 (mean of 51), requiring tooth extraction. The surgical procedures were performed only in private offices. Patients were screened, and all provided written and oral consent. They were enrolled from October 2008 to August 2010, and the study was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2000. The case-selection criteria included the absence of acute periodontal or odontogenic disease; women who were not pregnant nor intended to become pregnant during the study period; no history of cancer or human immunodeficiency virus; no untreated periodontal disease, including peri-apical disease; and the absence of any medical condition or therapeutic regimen that alters soft and/or hard tissue healing (i.e., osteoporosis, hyperparathyroidism, autoimmune diseases, chemotherapy or immunosuppressive agents, steroids, bisphosphonates, or similar type drugs).

All cases in this study were tooth extractions with immediate socket grafting. The teeth chosen for removal had little if any periodontal involvement. They were for the most part fractured teeth. Care was taken to remove the teeth atraumatically, so as to preserve the surrounding bone. In all cases the sockets had 4 or 5 wall defects. Any socket with a significant bone dehiscence was excluded from the study. After extraction the sockets were debrided and any inflammatory granulation tissue removed, also ensuring that there was suitable residual bleeding. The sockets were then filled with the CPS Putty material (Figures 1a, 1b), being careful not to touch the material with surgical gloves, or to impact the material too tightly. The volume of putty material used varied from 0.5cc to 1.0cc. No membranes were placed. Mucosal and periosteal releasing incisions were created to allow for tension-free primary closure, using 3-0 or 4-0 plain gut or chromic sutures. No pre or post-operative antibiotics were administered, and all patients were placed on Chlorhexidine oral rinse post-operatively. Pre and immediate post-operative radiographs were taken. Patients were then followed clinically and radiographically at time intervals of 1 week, 2-3 weeks, 6-8 weeks and 3-4 months. At the latter visit there was a discussion as to subsequent implant placement, which took place within the 3-6 month period. A number of patients decided against implant therapy.

**Core Biopsies**

In this study, on the day appointed for implant surgery, prior to the implant placement, a trephine bur with a 2.7-mm internal diameter (3.5 mm external diameter) was used to obtain a bone core from the center of the regenerated socket. The cores were left within the trephine and placed in 10% neutral buffered formalin for fixation. Decalcified specimens were prepared in 14 of the 22 cases that opted for subsequent implant placement. Undecalcified preparations were performed in the remainder (8 cases), with subsequent histomorphometric analysis.

**Histologic Preparation**

Undecalcified histologies were performed by the Division of Anatomic Pathology, University of Connecticut, Framington, Connecticut, USA. Specimens were fixed in formalin prior to decalcification. A stronger decalcification solution was
used for dense bone cores (e.g., Mandible). A high speed bone decalcifier-Decal Stat, [hydrochloric acid], (Decal Chemical Corp.) was used for decalcification of samples. The slides were stained with modified Hemotoxylin/Eosin and histologic analysis was performed. All histologic preparations for histomorphometrics were performed by the Division of Pathology, University of Minnesota, Minneapolis, Minnesota, USA. Upon receipt, specimens were dehydrated with a graded series of alcohols for 9 days. Following dehydration, the specimens were infiltrated with a light-curing embedding resin (Technovit 7200 VLC, Kulzer, Wehrheim, Germany). Following 20 days of infiltration with constant shaking at normal atmospheric pressure, the specimens were embedded and polymerized by 450 nm light; the temperature of the specimens never exceeded 40°C, then cut and ground.\textsuperscript{13,14} Specimens were prepared in an apico-coronal direction (parallel to the long axis) and were cut to a thickness of 150 µm on a cutting/grinding system (EXAKT Technologies, Oklahoma City, OK, USA). The cores were polished to a thickness of 45-65 µm with a series of polishing sandpaper disks from 800 to 2,400 grit, using a microgrinding system, followed by a final polish with 0.3 µm alumina polishing paste. The slides were stained with Stevenel’s blue and Van Gieson’s picro fuchsin and coverslipped for histologic analysis using brightfield and polarized microscopy.

**Histomorphometry**

Following non-decalcified histologic preparation, the cores were evaluated histomorpho-
metrically. The cores were digitized at the same magnification using a microscope (Zeiss Axiolab, Carl Zeiss MicroImaging, Thornwood, NY, USA) and a digital camera (Nikon Coolpix 4500, Nikon, Melville, NY, USA). Histomorphometric measurements were completed using a combination of programs (Adobe Photoshop, Adobe Systems, San Jose, CA, USA; NIH Image, National Institutes of Health, Bethesda, MD, USA). Parameters evaluated were the total area of the core, percentage of new bone formation, and percentage of residual graft material. The remainder of the area was considered soft tissue or void. The primary slide evaluated for each specimen was from the most central region of the obtained core. No comparison was made between the apical and coronal sections.

Figure 2A: Pre-surgical view of maxillary right first premolar with buccal fistula.

Figure 2B: Pre-surgical radiograph of maxillary right first premolar demonstrating periapical lesion and root fracture.

Figure 3: Placement of CPS Putty into #5 alveolus. Note the loss of buccal plate.
RESULTS
The study consisted of 22 alveolar sockets in all. 17 sockets were in the maxilla, with 11 in the anterior, cuspid-to-cuspid region and 6 in the posterior, premolar-molar region. In the mandible the remaining 5 sockets were in the molar region only. At the 5-6 month (average 5.4) post graft period all sockets demonstrated dense bone fill, with no visual evidence of residual graft material. Clinically, there was no significant difference noted in the “tactile feel” when drilling into treated sites as compared to adjacent non-treated sites, with bleeding in the graft site osteotomies showing clear evidence of vas-
cular ingrowth. Radiographs demonstrated very substantial bone fill in the sockets. The trabecular pattern in the regenerated areas appeared very similar to the adjacent (native) bone.

A representative case is that of a 74 year old female, in stable health, who presented with a fistula in the buccal mucosa of the upper right first premolar (Figure 2a). Radiographic evaluation revealed a periapical lesion, secondary to a root fracture (Figure 2b). After evaluation, the decision was made to extract the tooth, with the view to eventual implant placement. The...
tooth was extracted atraumatically, at which time it was determined that the quality of bone was insufficient for immediate implant placement, due to a significant loss of buccal plate. The alveolus was curetted and CPS Putty was placed (Figure 3). The patient was recalled 4 months post graft for evaluation, and a decision was made to place an implant at that time. After raising a full thickness flap at the crest of the ridge it was noted that the CPS Putty had been replaced by regenerated bone that had a normal clinical and radiographic appearance (Figures 4a, 4b). The quality of the regenerated bone was excellent with healthy natural bleeding and a completely regenerated buccal plate, which permitted normal implant placement (Figure 5). A core was taken prior to implant placement. A representative high magnification sample of the decalcified Hematoxylin-Eosin sections shows substantial portions of vascularized dense vital bone, interspersed with a normal connective tissue matrix (Figure 6). The final prosthetic result showed a normal clinical crown form with healthy peri-implant tissue (Figure 7), as well as a normal trabecular bone appearance (Figure 8).

Figures 9a and 9b shows representative histologic images of an undecalcified core, at increasing magnifications, taken from the bone graft site of a separate case. Histomorphometric evaluation of all the undecalcified cores revealed an average vital bone content of 48.2% ± 6.8 (standard deviation). As a comparison, autogenous trabecular bone volumes, which can vary widely, have a range from under 20% to 40%.15 A residual graft content of 2.4% ± 1.4 was found for the calcium-phosphosilicate bone graft, following a healing time of 5.4 months ± 1.5 months.

**DISCUSSION**

The results of the present study show that in post-extraction alveolar sockets, CPS Putty graft material is able to achieve bone regeneration results that are favorable for the placement of subsequent osseointegrated implants. In addition, by eliminating the need for second site donor harvesting and the resulting increased risk of morbidity, the use of this synthetic graft substitute becomes very appealing.

Historically the function of biomaterials has been to replace damaged and missing tissues.7,16 Compositions such as 45S5 Bio-glass, having the highest bioactivity rate, allow for rapid trabecular bone regeneration with an architecture, volume and bio-mechanical bone quality that matches the original bone in that region.17 The multi-stage mechanisms and kinetics of surface reactions of CPS and bone have been extensively covered.18,19 What is clear is that the surface reactions take place within a short, 2-4 day time frame,20 with attachment of stem cells and the subsequent proliferation and differentiation of osteoblasts rapidly occurring on the surface of the bioactive material.21,22 Moreover, Xynos et al were able to show that modulation of the osteoblast cell cycle is achieved by the controlled release of ionic dissolution products from CPS particles.21 In particular, the ionic dissolution products of biologically active Silicon and Calcium released from these bioactive glasses stimulate the genes that control osteoblast differentiation, as well as proliferation. Gene array analyses confirmed that after several hours of exposure of human primary osteoblasts to the soluble chemical extracts from CPS particles, several gene families were up-regulated or
activated: Genes that encode for nuclear transcription factors and growth factors, especially IGF-II. Among the differentially expressed genes were those involve with cell cycle regulation, differentiation and proliferation, as well cell adhesion and bone mineralization. These studies all point to a capability possessed by CPS particles to stimulate differentiation toward a cell lineage with therapeutic potential in tissue engineering. In addition there is evidence that these particles possess a transient antimicrobial activity, most probably due to a direct and indirect pH-related effect.

Human clinical studies and reports of bioactive glasses use have dealt, for the most part, with repair of periodontal and alveolar ridge defects, with more limited studies in orthopedics and other areas of the head and neck. Lovelace et al. showed that freeze-dried bone allograft gave similar pocket depth reduction in moderate and deep periodontal osseous defects when compared with CPS particles. Other authors who have treated infra-bony defects with CPS particles have shown similar results, with attachment gains of 2.7 to 3.0 mm and 2.8 mm and reductions in pocket probing depth of 3.7 to 4.4 mm, with preoperative probing depth at 7.9 to 8.1 mm. Significant improvement in probing depths has also been reported when CPS particles were used in the treatment of class II furcation defects. These results have not been uniform. Other authors have found only a slight, non statistically significant, improvement in infra-bony defects treated with CPS particles in comparison with those of controls treated with open debridement only. The reasons for the discrepancies between similar trials in the literature remain speculative but may be attributed to various factors, including the disease and patient population variations, the types and depths of the defects, the baseline clinical conditions, or the evaluation methods used. CPS particles have been used in a limited number of sinus augmentation studies. In a histomorphometric study comparing augmentation with 100% autogenous iliac crest bone to a composite graft, consisting of 80-90% CPS particles and 10-20% autogenous iliac bone, it was found that the composite graft accelerated healing time to about 6 months, compared to 12 months for the autogenous graft alone. In a recent comparative histomorphometric study by Galindo-Moreno et al., bone core biopsies were taken 6 months after sinus grafting with either a bovine hydroxylapatite (HA) or CPS particles. No bone loss was observed radiographically or clinically in both groups. Histologic analysis revealed that both grafts had a high biocompatibility. In the bovine HA-containing group, minimal xenogenic graft absorption was noted. In contrast, the CPS group samples presented a high absorption rate with some remaining particles imbedded in new normal bone.

In the present study tissue regeneration after graft placement occurred without complications. Most significantly, there was a very high level of bone formation within the implanted material. This was evidenced by new bone formation, including mature trabecular bone with osteocytes in lacuna, as well as marrow formation within the new bone structure. The degree of trabecular bone formation between the implant particles was consistent with the previously reported histologic results in animal models after a similar time frame. In these studies new bone formed around all particles,
with a progressive thickening of the bone layer as the particles decreased in size. The histologic findings of this study indicate that the graft material followed the same pattern of bone formation as seen in other human and animal studies. A high degree of neovascularization was seen within the grafted area, which is crucial for the support of new bone formation. There was no evidence of reduction of the overall size of the graft material and newly formed bone, although longer study duration would be necessary to demonstrate no long-term resorption. In addition there was no evidence, either clinically or histologically, of any significant inflammatory reaction surrounding the graft material, suggesting good tissue compatibility.

**CONCLUSION**

The high percentage of vital bone content, after a relatively short healing phase, suggests that bioactive calcium phosphosilicate putty can be a reliable choice for osseous regeneration in cases of crest preservation and implant related surgeries.

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DISCLOSURE
NovaBone Products (Manufacturer of the bone graft material used in this study) provided partial research support for this project.

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Two approaches to the early (preload) osseointegration failure of a dental implant have been described: placement of a new implant after a period of wound-healing, or the immediate insertion of a larger implant. We present the first report of immediate reimplantation at the same site using the same implants, performed in three patients with three different implant brands, which have survived for five years to date. Neither the implants nor the screw-retained fixed prostheses have shown any clinical or radiological sign that casts doubt on the success of the reimplantation. It is not our intention to describe a new protocol for cases of implant failure, but rather to report the successful outcome of an unusual approach, using two distinct implant systems, which was adopted in response to the specific requirements of our patients.

KEY WORDS: Dental implant, failure, reimplantation, replacement, osseointegration

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INTRODUCTION

There are currently two approaches to implant replacement. One is to wait until the implant bed is fully healed, a period ranging from the 8 weeks recommended for some systems to the 4-5 months or longer proposed by some authors. The other approach is immediate reimplantation using a larger implant. We report three cases of immediate reimplantation of the same implant at the same site which have now survived for 3 years. After loading with a screw-retained fixed prosthesis, clinical and radiological follow-up examinations confirmed the successful outcomes.

Case 1

A 58 year old female, non-smoker, with no clinical findings or history of interest, was referred for replacement of teeth 3 and 4. Figure 1 shows the panoramic radiograph taken at the first visit. Tooth 4 was replaced with a 3.3 x 12mm implant and tooth 3 with a 3.8 x 10mm implant, using Klockner SK2 implants after applying expanders due to the narrowness of the crest. Osteotomes were used to achieve a slight atraumatic sinus floor elevation (Figure 2), leaving the heads of the implants exposed (semi-submerged technique). An adequate primary stability was obtained (Periotest value of -2).

After 8 weeks, the manufacturer’s recommended osseointegration period, the peri-implant tissue had a good appearance, with no mobility or discomfort and with a metallic sound on percussion. Periapical radiographs showed no mesiodistal radiolucency in either implant, and transfers were attached to take impressions. When the transfers were removed, the implant in position 3 unscrewed in a pain-free manner (Figure 3). The patient refused our proposal to wait for 8 weeks until the empty socket was healed before placing a new implant. She also refused surgery for placement of a wider implant. We therefore decided upon the immediate utilization of the same implant after confirming the absence
of clinical or radiological signs of infection.

After anesthetizing the patient and scraping the socket with a Lucas-type surgical curette to eliminate soft tissue, the implant was washed with physiological saline and reimplanted, screwing it into the same surgical bed with no drilling. It was introduced a further 2 mm into the maxillary sinus (Figure 4), achieving a good primary stability (Periotest® value of -1). Examination at 8 weeks showed clinical and radiological signs of osseointegration. Impressions were then taken, the corresponding metal test and bisque try-in were performed, and the definitive prosthesis was placed (Figure 5). Three years later, the implant and prosthesis show no clinical or radiological signs that cast doubt on the successful outcome (Figure 6).

Figure 3: Case 1. Intraoral clinical photo at the time of initial implant failure.

Figure 4: Case 1. Reimplantation of implant #3 (2 mm deeper).

Figure 5: Case 1. Radiological image of completed prosthesis.

Figure 6: Case 1. Clinical image at 36-month follow up.
Case 2
A 67 year old female, non-smoker, with no clinical findings or history of interest was referred for replacement of teeth 3 and 19. Figure 7 depicts the initial panoramic radiograph. The teeth were replaced with Osteoplus Iridium® implants (3.8x12 mm). Implants were clinically and radiologically assessed monthly (Figure 8). At three months (initiation of prosthetic phase), the implant in position 19 explanted in a pain-free manner, with no suppuration or clinical signs of inflammation. The socket was curetted and the same implant was cleaned with physiological saline solution for 2-3 minutes and replaced in the same bed, obtaining good primary stability with a Periotest® value of -1 (Figure 9). Crowns were fitted at three months, and both implants have remained problem free to date (Figure 10).
Case 3
A 32 year old female, non-smoker, with no clinical history of interest was referred for replacement of tooth 9. Figure 11 shows the initial radiograph. Tooth 9 was replaced with a 3.8x14 mm Osteoplus Iridium® implant. Figure 12 shows the implant in position 9 after its original placement. At one month, this implant explanted in a pain-free manner. Since there were no clinical signs of gingival inflammation and there was no wider implant available at that time, the socket was curet-
ted, and the same implant was cleaned with physiological saline solution and placed in the same bed, obtaining a good primary stability (Ostell® 57) (Figure 13). At 3 months, the implant was satisfactorily loaded (Figure 14).

DISCUSSION
We do not know the cause of the original implant failure in these cases. The recommended surgical procedure was meticulously followed, there were no clinical or radiological signs of infection, and the gingiva showed
no signs of inflammation/infection after implant removal. Moreover, in the first two cases, there was no radiographic evidence of alteration to the implant-bone interface at transfer attachment.

The first two patients were offered the two standard treatment options but refused to accept any waiting period or undergo any further surgery for placement of a wider implant. Mardinger et al. found that the main reasons given by patients for refusing reimplantation were the additional costs (27%), fear of additional pain (17.7%), and fear of a second failure (16.2%). Faced by this situation in our patients, we decided to replace the same implant immediately, minimizing potential bone resorption at the site. The same approach was adopted in the third patient because a wider implant was not available from the manufacturer in question at that time.

Grossmann and Levin described a survival rate of 71% for single implants placed in sites of previously failed implants after a mean waiting period of around 5 months, and a three- to four-fold higher proportion of lost fixtures has been reported in comparison to non-affected first-time implant sites. According to Evian and
Cutler, a wound-healing period is not mandatory after implant failure as long as three prerequisites are met: 1) a correct preparation of the bed to eliminate invasive soft tissue; 2) use of a new implant with a larger diameter than the original and; 3) adequate available bone for the procedure. Only the second criterion was not met in our cases, although primary stability was obtained in the first case by inserting the coronal part a further 2 mm, providing bicortical support and having a similar effect as placing a larger implant (Figure 5). According to the literature, when substantial infection is associated with an explanted implant, the clinician may have to postpone implant placement to permit resolution of the infection. This was not the case with the present patients.

It was reported that cleaned implants reinserted into dog mandible achieved integration and obtained the same amount of bone-to-implant contact as did a new implant. Another animal study found that plaque-contaminated rough implant surfaces can re-osseointegrate after cleaning with different substances, including citric acid (30 s), 10% hydrogen peroxide (1 min), or physiological saline (1 min). The authors concluded that any biological debris that might not have been removed by their cleaning methods did not appear to significantly alter the osseointegration pattern. Among methods for cleaning contaminated implant surfaces, Parlar et al. found that in situ spraying with saline solution for 3 minutes gave the most favorable outcomes. These results cannot be extrapolated to humans, but they support our decision to washing the failed implants with saline before their reimplantation, which may have contributed to the successful outcomes.

Although biological tests were not applied, no clinical or radiological signs of infection were observed in these patients, allowing the same implant to be reutilized in the same bed after appropriate treatment, as in the avulsion of natural teeth. Besides washing the implant with saline solution, manual curettage was performed to eliminate granulation tissue, leaving a bleeding surface at the explanted site.

The novelty of this report is that an immediate reimplantation was performed after implant failure using the same implant, obtaining outcomes that remain stable after 5 years. It is not our intention to describe a new protocol for cases of implant failure but rather to report the successful outcome of an unusual approach, using two distinct implant systems (Klockner® and Osteoplus Iridium®). We adopted this strategy in extremis because there was no pain or clinical signs of inflammation and because of the specific demands of our patients and the prospect of a delay in placing a new implant (freely offered by implant companies). Further studies are warranted to test the possibility that implants can be re-inserted when there are no clinical or radiological signs of infection, avoiding the need for a waiting period or further surgery.

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Since their introduction nearly fifty years ago dental implants have revolutionized dentistry, changing the way we approach everything from dentures to single unit crowns. One treatment that has changed considerably with the progression of dental implants is the extraction of teeth. Contemporary dental implant treatment recommends at least 1.0 to 1.5mm of bone surround all aspects of the fixture. To achieve such a goal, preservation of existing bone is essential during tooth removal. This concept has ushered the term “atraumatic extraction.” In this procedure, atraumatic refers to inducing as little damage as possible to the surrounding bone and a number of instruments have been introduced to achieve this goal. Use of very small 15c scalp blades, periotomes, and piezoelectric surgical units have been documented for atraumatic tooth removal. Recently, an automated version of the periotome has been introduced. The aim of this paper is to demonstrate how the automated periotome is used as an adjunct for atraumatic extraction of multi-rooted teeth.

**KEY WORDS:** Atraumatic tooth extraction, Powertome, automated periotome, dental implants

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Since their introduction nearly fifty years ago dental implants have revolutionized dentistry, changing the way we approach everything from dentures to single unit crowns. One treatment that has changed considerably with the progression of dental implants is the extraction of teeth. In the past, tooth removal was often approached with the mindset of getting the tooth out of the mouth as fast as possible with little to no thought given to the condition of the surrounding bone. In fact, many older texts advocated bone removal or fracture to facilitate easier tooth extraction.1

Contemporary dental implant treatment recommends that at least 1.0 to 1.5mm of bone surround all aspects of the fixture.2 3 To achieve such a goal, preservation of existing bone is essential during tooth removal. This concept has ushered the term “atraumatic extraction.” In this procedure, atraumatic refers to inducing as little damage as possible to the surrounding bone and a number of instruments have been introduced to achieve this goal.4 5

Use of very small 15c scalpel blades (figure 1), periotomes, and piezoelectric surgical units have been documented for atraumatic tooth removal.4 5 The concept of atraumatic tooth removal is simple: remove a tooth with as little damage as possible to the surrounding alveolar bone. Although this sounds easy, the execution of atraumatic tooth removal is another story, especially when comparing removal of single rooted teeth to multi-rooted teeth.

Recently, an evolution of the periotome was introduced to speed atraumatic tooth extraction. Unlike traditional periotomes which require a surgical mallet to advance the thin blade down the periodontal ligament (PDL), the Powertome® (Westport Medical, Salem, Or. USA) employs a proprietary foot-pedal activated handpiece for this purpose (figure 2). The aim of this report is to document and demonstrate the use of the Powertome® for atraumatic removal of multi-rooted molar teeth.

**SINGLE ROOTED TEETH**

Single rooted teeth include incisors, canines,
and the majority of premolars. The roots of these teeth tend to have a tapered shape with the majority of their attachment surface area located coronally.\textsuperscript{6} During atraumatic removal of these teeth, thin blades are used to sever the PDL fibers attaching to the coronal aspect of the root. Once these coronal fibers, which comprise the largest area of attachment for the tooth, are severed, the tapered nature of the single root allows for relatively simple removal (figure 3).

**MULTI-ROOTED TEETH**

Multi-rooted teeth include molars and some premolars. In a study of root anatomy, Gher and Vernino found that 56\% of maxillary first premolars had 2 roots with a bifurcation located in the middle third of the root.\textsuperscript{7} Canines and incisors may be multi-rooted, but these tend to be anomalies rather than the norm. Unlike single rooted teeth which have the majority of their attachment located at the coronal aspect of the root, multi-rooted teeth have only 1/3 of their total attachment located in the coronal portion of the root superior to the furcation. Additionally, while the roots of single rooted teeth taper and narrow apically, the roots of multi-rooted teeth often flare apart from one another. It is the flaring of these roots which makes it nearly impossible to remove an intact molar without damaging the supporting alveolar bone.

**ATRAUMATIC EXTRACTION OF MULTI-ROOTED TEETH**

Extraction of multi-rooted teeth without damaging the supporting bone poses a problem. Because the roots of these teeth often flare apically, extracting the tooth in a coronal direction without damaging the bone is often impossible. It is a simple matter of physics: a wide base prevents removal through a smaller hole. This same concept is utilized in the design of flared arrowheads. After the arrowhead pierces the flesh or bone, the flared base prevents its removal. If extraction of the arrowhead is attempted forcefully, significant tissue damage ensues. Multi-rooted teeth with flared roots are not much different. If this type of tooth is
forcefully removed intact with forceps, one of two things will happen. Either the tooth is going to fracture, making its removal that much more difficult, or the supporting bone is going to fracture allowing for removal of the tooth. In the latter scenario, the patient has been done a disservice as additional surgical techniques will be required to repair the extraction site. Fortunately, with modern extraction techniques, these scenarios can be avoided.

The simplest way to remove multi-rooted teeth in an atraumatic fashion is to convert the multi-rooted tooth into multiple single rooted segments. This can be accomplished by cutting the multi-rooted tooth into multiple pieces with the aid of a surgical drill or piezosurgical device. Mandibular teeth are typically sectioned bucolingually into two pieces (figure 4) while maxillary teeth are sectioned in a “Y” fashion into three pieces (figure 5). The multi-rooted mandibular tooth is converted into two mesial and distal segments while the maxillary teeth are converted into three mesiobuccal, distobuccal, and palatal segments. Following sectioning of the teeth, an elevator is used to gently manipulate the separated segments. To protect the septal bone apical to the furcation of the multi-rooted teeth (figure 6), the rotary bur or piezosurgical device can be stopped just short of the base of the furcation. This small remaining portion of intact tooth structure easily fractures during manipulation with the elevators. This is the traditional way to remove multi-rooted teeth via sectioning.

A modern update to this technique is employment of the periotome. With the periotome, a thin blade is advanced down the PDL severing the fibers that attach the bone to the cementum of the root. This tends to be a slow and tedious process as a mallet is often required to advance the periotome down the tight PDL space. A recently introduced device called a Powertome® essentially automates use of the periotome. With the Powertome® a thin periotome-like blade is attached to a handpiece that is controlled via foot pedal. Activation of the foot pedal moves the Powertome® blade to a preset tap

Figure 5: Maxillary molar sectioned into three pieces.

Figure 6: Intact furcal bone after extraction.
that is programmed into Powertome® control unit. The Powertome® blade only taps on the downstroke, creating a controlled amount of force that eliminates the need for malleting.

In the cases demonstrated in this paper, the Powertome® was used prior to sectioning teeth (figure 7) with a rotary bur hand piece. Use of the Powertome® in this fashion significantly improved ease of extraction of these multiple rooted teeth. In cases of single rooted teeth, the Powertome® is often the only tool necessary for removal of the tooth. Converting the multiple-rooted tooth into numerous single rooted segments, allows for extraction similar to a single rooted incisor or canine.
Case 2
Atraumatic removal of maxillary first molar (figures 11-14).
Case 3
Atraumatic removal of mandibular first molar (figures 15-17).

Figure 15

Figure 16

Figure 17
Case 4
Atraumatic removal of maxillary first molar (figures 18-21).

Figure 18

Figure 19

Figure 20

Figure 21
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Disclosure
The authors report no conflicts of interest with anything mentioned in this paper.

References
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- BioXclude over grafted socket
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Case Courtesy of Paul S. Rosen, DMD, MS, Yardley, PA

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This case report illustrates perforation of the superior cortex of the inferior alveolar canal following implant placement immediately into fresh extraction socket of a mandibular molar. The method to prevent this complication is also discussed.

**KEY WORDS:** Dental implant, inferior alveolar nerve, tooth extraction, complication
INTRODUCTION
The original implant surgical protocol proposed by Branemark\(^1\) involves open flap access, step-wise osteotomy of the bony ridge, implant placement followed by good primary closure. If the patient presents with a failing tooth, extraction must be performed and the socket allowed to heal for a duration of three to six months before replacement with a dental implant can be considered. After complete socket healing has taken place, bony ridge and soft tissues deficiencies that render the site unsuitable for implant placement need to be addressed first. A variety of hard and soft tissue ridge augmentation may be used but overall treatment time is prolonged.

Immediate implant placement may be defined as implant placement immediately following tooth extraction and as part of the same surgical procedure,\(^2\) or as implant placement immediately following extraction of a tooth which must be combined in most patients with a bone-grafting technique to eliminate peri-implant bone defects.\(^3\) This technique has a number of proposed advantages such as preservation of bone and soft tissue, decreased total treatment time, reduced number of surgical procedures, reduced overall cost and better patient acceptance.\(^3,4\) However, discrepancies between the size of the implant and sockets, poorly vascularized infected bone at the implant site and difficulty to control three dimensional implant position and primary stability are some of the surgical challenges that operators face.\(^4\) Therefore, this unique procedure is generally not recommended for the novice surgeon.\(^3\)

This article describes a case of immediate implant placement into a fresh mandibular molar extraction socket performed by an experienced Oral & Maxillofacial Implant Surgeon whereby the inferior alveolar canal is unintentionally perforated.
CASE REPORT

Clinical Evaluation
The patient was a 49 year old male that presented with a failing mandibular left molar that required extraction followed by replacement with a dental implant (Figures 1a, 1b). Standard clinical assessment included documentation of any significant past medical history, general health status and smoking habits. The patient did not present with significant medical or systemic issues that would compromise dental implant success. Clinical assessment included extra-oral examination...
followed by intra-oral examination. Thereafter, implant site specific evaluation was carried out jointly with a prosthodontist. This consisted of inter-occlusal space, dental examination as well as hard and soft tissue assessment. In particular, soft tissue assessment consisted of evaluating the biotype, volume and dimensions of mucosa to ensure that at least 2 to 3 mm of attached soft tissue, preferably keratinized, would remain circumferentially around the healing abutment following flapless implant placement. The mandibular left molar was indicated for extraction as it was deemed to have a poor restorative prognosis because of an enlarged buccal wall cavity which had pulpal involvement and subgingival extension.

**Radiographic Assessment**
Radiographic investigations (Figures 2a, 2b) consisted of a routine panoramic film and cone beam computed tomography (CBCT). The surgeon then evaluated the radiographs to confirm the possibility of implant placement immediately into the extraction socket. This is based on bone volume sufficiency for the intended implant extension apically beyond the root apices crestal to the inferior alveolar canal. Based on the above findings, the patient fulfilled the criteria for immediate implant placement into the socket of the mandibular left molar. A surgical guide was fabricated to assist
in a prosthodontically favorable placement of the implant and the case scheduled for immediate single stage placement of a 12mm length, wide diameter (4.8mm) parallel ITI implant with a 6.5mm diameter Wide Neck polished transmucosal collar (Sandblasted Large-Grit Acid–Etched surface, International Team for Implantology, Straumann® AG, Waldenburg, Switzerland).

**Surgical Procedure and Outcome**
The patient was prescribed oral amoxicillin 1.0 gram an hour pre-operatively. The surgical procedure was carried out under local anesthesia...
in sterile surgical conditions. The tooth was luxated carefully with a periotome before introducing the forceps to deliver the tooth. However, the extraction was complicated by repeated fractures of the crown and had to be eventually removed in pieces (Figure 3a) by sectioning with a surgical bur. The buccal and lingual walls of the socket were fortunately preserved intact (Figure 3b) following tooth removal. A surgical stent (Figure 4) was then used to guide the osteotomy of the implant site throughout the procedure.

The site preparation was carried out to an
Yong

intended depth of 12mm for the placement of the implant (Figure 5). The planned crestal position of the implant head was 3mm beneath the gingival margin and the subsequent drilling depth carried out according to this reference. The surgical guide was used throughout to ensure a prosthodontically favorable placement of the implant along with copious irrigation. In addition, the osteotomy sites were directly cooled with irrigation by removing the drills in the sequence.

During the drilling the patient complained of increased painful sensitivity as the drills were reaching the final depth. At one point, he felt extreme pain and the drilling process was halted for inspection of the osteotomy. However, there was no pulsative bleeding observed from the base of the implant preparation. A final lavage of the osteotomy was carried out to ensure a debris free site before inserting the implant (Figure 6).

The implant was then inserted (Figure 7a) first with a handpiece at the recommended torque and final seating done manually with a wrench. The final seating was confirmed when the implant bottomed out at the base of the osteotomy and did not show further apical movement. The transmucosal polished collar was also verified to be at the correct crestal position 3mm beneath the gingival margin for proper crown emergence. The patient did not have further complains of any pain or discomfort during the implant insertion. The implant had good primary stability. The fixture mount was then removed and a healing abutment placed (Figure 7b). The residual peri-implant socket defect was grafted with alloplastic bioactive glass bone substitute (Figure 8) and a collagen dressing over the entire site secured with a figure of 8 suture (Figure 9).

Immediate post operative panoramic and periapical radiographs were taken. It was noted from these radiographs that the superior cortex of the inferior alveolar canal showed loss of cortical continuity at the apical tip of the implant (Figures 10a, 10b). The bioactive glass bone substitute was also noted to be incompletely condensed around the middle third of the implant.

The patient was informed of the findings and discharged with post operative antibiotics and analgesics. Standard post operative instructions were also given. The patient was followed up a week post surgery and did not present with any mental paresthesia. Subsequently he was followed up at one and 3 months post surgery. Radiographs showed improvement in the tissues surrounding the implant (Figure 11) and the patient reported no paresthesia. Soft tissue healing around the implant healing abutment was excellent (Figure 12). The patient was then referred for prosthodontic restoration of the implant (Figure 13).

Figure 13: Final prosthetic restoration.
DISCUSSION
Immediate implant placement into fresh extractions sockets can be considered as a challenging procedure for the implant surgeon. The technical demands of atraumatic tooth extraction, preservation of soft and hard tissue architecture, osteotomy preparation using regularly shaped drills in an otherwise irregularly shaped tooth socket, implant insertion with primary stability achievement, grafting of the residual peri-implant socket defect and stabilization of the entire site present as a surgical protocol only to be undertaken by trained and experienced personnel.

Surgical complications have been well documented including bony dehiscence/perforation of the bony housing during site preparation, incomplete seating of cover screw and/or healing abutment and lack of primary stability. In addition to the mentioned difficulties, the surgeon needs to also factor in anatomical roadblocks such as the nasal floor, maxillary sinus cavity, and in this particular case, the inferior alveolar canal.

In retrospect, the author feels that the following lapses had occurred resulting in this complication. Firstly, the treatment planning with the cone beam CT should have been more careful. The scans were not manipulated in line with the path of implant insertion (Figure 2b), causing miscalculation in the bony adequacy above the canal for placement of a 12 mm length implant. Secondly, at the first instance when the patient complained of pain during drilling, a decision should have been made to change the depth of drill to 10mm instead of 12mm. This is because anecdotally, pain and sensitivity would usually be experienced as the drills approach within 2mm away from the canal. The author felt that should the above precautions were taken; perforation of the superior cortex of the canal would have been avoided in this otherwise uneventful outcome with a satisfactory restorative result.

CONCLUSION
Immediate implant placements into fresh extractions sockets of mandibular molars must be carefully planned and executed by experienced surgeons for a favorable outcome. The surgeon must be prepared to alter the surgical plan to avoid complications.

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

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Management of Bilateral Severe Gingival Recessions in a HIV Positive Individual with Lateral Sliding Flaps

Shaziya A. Haque, DDS, MS1 • Shilpa Kolhatkar, DDS, MDS2 Crystal McIntosh, DDS, MS3 • Monish Bhola DDS, MSD4 James R. Winkler, DDS, PhD5

Abstract

BACKGROUND: Aggressive tooth brushing and plaque induced inflammation around labially prominent teeth are common reasons for recession. Severe recession defects were present on labially prominent teeth #22 and #27 in a HIV-positive individual.

METHODS: Lateral sliding flaps (LSF) were selected for root coverage because they have good vascularity. Healing patterns of the donor and the recipient sites were uneventful.

RESULTS: Root coverage of 80% (#22) and 50% (#27) was achieved. At 6 months, stability of root coverage with minimal probing depths and a thick band of keratinized tissue was observed.

CONCLUSION: This case report illustrates that successful root coverage can be obtained in a HIV positive individual using LSF.

KEY WORDS: Gingival recession, gingival graft, HIV

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INTRODUCTION

The most recent World Health Organization data estimates that 33 million (30-36 million) people are affected globally with the human immunodeficiency virus (HIV). In the United States, approximately 1.1 million individuals are living with diagnosed or undiagnosed HIV. The use of highly active antiretroviral therapy (HAART) has significantly reduced mortality and morbidity due to the HIV infection and decreased the progression of HIV to acquired immunodeficiency syndrome (AIDS) by 42%. The effectiveness of HAART is dependent on past medical history, stage of HIV disease, demographic characteristics, presence of co-morbidities, HAART drug regimes, drug duration and the use of antifungal prophylaxis and compliance.

Recognizing the oral lesions associated with HIV is often the primary concern of the dental practitioner, however many patients also routinely require comprehensive dental treatment. Outcomes of nonsurgical periodontal treatment in HIV positive patients have shown to be comparable to the general population but limited information is available to guide dentists on how to adequately manage the surgical dental needs of HIV positive patients. Complications following extraction of teeth in the HIV positive population have been studied frequently. Other dental treatments like the placement of dental implants, root canal therapy, and restorative treatment have also been reported. However, there is paucity of data regarding the surgical management of periodontal needs in this group. To our knowledge, there is only one other description of root coverage on a non-restored surface in a HIV positive patient which was primarily due to the presence of severe gingival recession. The patient was diagnosed with HIV in June 2001 and was regularly monitored by his physician. No other systemic conditions were reported and he denied any history of smoking or alcohol intake. His antiretroviral therapy included Atazanavir (Reyataz®, Bristol-Myers Squibb Company) Ritonavir and Emtricitabine (Norvir®, Abbott Laboratories) and Tenofovir (Truvada®, Gilead Sciences, Inc.).

A thorough intraoral dental examination revealed crowding of the mandibular anterior teeth with bilateral labio-version and rotation of the mandibular canines (figure 1). In this case report, we demonstrate successful root coverage of bilateral severe recession seen on mandibular canines in a HIV-positive patient by utilizing lateral sliding flaps (LSF).

CASE REPORT

A 44-year-old African American male was referred to the University of Detroit Mercy, Department of Periodontology, Detroit, Michigan for a periodontal consultation. His chief complaint was sensitivity on the mandibular left and right canines which was primarily due to the presence of severe gingival recession. The patient was diagnosed with HIV in June 2001 and was regularly monitored by his physician. No other systemic conditions were reported and he denied any history of smoking or alcohol intake. His antiretroviral therapy included Atazanavir (Reyataz®, Bristol-Myers Squibb Company) Ritonavir and Emtricitabine (Norvir®, Abbott Laboratories) and Tenofovir (Truvada®, Gilead Sciences, Inc.).
severe recession measuring 11 mm (#27) and 10 mm (#22) on the mid-facial surfaces was noted. An occlusal analysis revealed that #22 was in a cross-bite relationship with tooth #10 and an edge-to-edge relationship was present between #7 and #27. The gingival tissues were inflamed and erythematous on #22 and #27 while the gingiva around the incisors displayed minimal clinical signs of inflammation. Copious amounts of plaque were present on the mandibular canines and the probing depths ranged from 2 mm to 3 mm. A radiographic exam revealed no carious lesions or any root surface anomalies. When tooth vitality was tested, both teeth responded normally to cold stimulus (Cold Snap Freeze Spray, Benco Dental, Grand Rapids, MI). Based on the radiographic (figures 2a and 2b) and the clinical examinations (figures 3a and 3b), the recession defects were categorized as a Miller Class III. The patient was presented with two treatment options for the management of his severe gingival recession. The first treatment required orthodontic therapy to correct the malocclusion combined with soft tissue grafts for root coverage on #22 and #27. The alternative treatment plan consisted of only the periodontal surgery to provide root coverage using LSF. The patient chose the latter treatment option due to financial limitations. An informed consent was obtained for the procedure and the patient was advised that complete root coverage may not be possible due to the severity of the recession.

His pre-surgical laboratory values were: CD4+ T-lymphocyte count 404 cells/mm³, viral load 4,800 copies/ml, platelet count 292,000 plate-
Figure 3a: Preoperative clinical view of tooth #27 showing midfacial recession measuring 11mm.

Figure 3b: Preoperative clinical view of tooth #22 showing midfacial recession measuring 10mm.

Figure 4: The initial incision started approximately 1.5mm apical to the gingival margin of tooth #26 and extended mesially to tooth #25. A vertical incision was made at the mucogingival junction and was connected to the initial incision at #25.

Figure 5: Reflection of a full thickness flap. Periosteal releasing incisions were made to ensure passive movement of the flap.
lets/ml, absolute neutrophils 2.8 x 10³/µL and a total white cell count 5.3 x 10³/µL. His hemoglobin was 13.3 g/dL and the hematocrit was 38.7%. The vital signs were recorded prior to the surgical procedure and profound anesthesia was achieved. Minimal recontouring of the root surfaces on #22 and #27 was performed using a round end flame-shaped carbide bur (7406 Brasseler, Savannah, GA) primarily to facilitate flap adaptation. The root surfaces were thoroughly debrided using hand instruments and the gingival margins were de-epithelialized on the mesial and distal surfaces of both the teeth using a 15C blade (Stainless Steel Surgical Blade Miltex Inc., York, PA). The initial scalloped incision was started 1.5mm apical to the gingival margin of #26 and extended mesially to #25. A vertical incision was made which started at the mucogingival junction of #25 and connected to the initial incision (figure 4). Full thickness mucoperiosteal flap were then elevated and periosteal releasing incisions were made to ensure passive adaptation of the flaps (figure 5). Root conditioning (125mg tetracycline/1mL of saline) was performed for two minutes. The pedicle flap was coronally advanced and sutured slightly coronal to the cementoenamel junction (CEJ) with 4-0 silk (Ethicon Inc, Johnson & Johnson, Cornelia, GA) (figure 6). A similar surgical procedure was performed to obtain root coverage on #22. No periodontal dressing was used. The patient was prescribed 0.12% chlorhexidine gluconate (CHX) mouth rinse and an analgesic (ibuprofen 800mg 1 tablet TID prn) for the management of the pain. Verbal and written post-operative instructions provided to the patient included no brushing at the surgical sites for 2 weeks, gentle rinsing with CHX and limited facial movements. The patient was recalled for post-operative assessment at 1, 2, 4, 12 and 24 weeks. Uneventful healing of the donor sites was

Figure 6: The pedicle flap was coronally advanced and sutured with silk sutures.

Figure 7: Post operative view at 2 weeks. The sutures were removed with gentle debridement around the graft sites.
observed. At all the post-surgical visits, gentle debridement of the surgical sites was performed using hand instruments. At the 1 week post-surgical visit, the patient admitted to using a toothpick on #27. This disrupted the healing of the surgical site on #27. The patient was instructed to leave the surgical sites undisturbed to facilitate healing. Sutures were removed at the 2 week post-surgical visit (figure 7). At the 6 month post-surgical visit, despite the presence of plaque around the teeth, the root coverage appeared to be stable. The recession defect decreased from 11 mm to 5 mm on #27 and on #22 recession defect reduced in height from 10mm to 2mm. The probing depths remained between 2 mm to 3 mm and the recipient site showed good color match along with significant gain in keratinized tissue (figures 8a and b).

**DISCUSSION**

Several authors have investigated dentist's attitudes in the treatment and dental management of HIV positive patients. Many dental professionals assume that treating HIV positive patients involves greater risk of infection and post operative complications. This is not unsurprising because of the immunosuppressed state associated with HIV. One might hypothesized that this would lead to disturbance in the normal healing pattern following invasive dental procedures. In fact numer-
rous studies have refuted this assumption and have found no differences in post surgical complications or infection rates following common surgical dental procedures. A recent report concluded HIV positive patients do not experience greater tooth loss when compared to individuals not diagnosed with HIV. Thus, we can expect HIV positive patients to seek comprehensive dental care including surgical interventions aimed at correcting the presence of gingival recession. In fact, there are only two case reports which describe successful soft tissue grafting procedures in HIV positive patients. The first report published was that of a 50 year old HIV positive male with a 30 pack year history of smoking.

The authors used two large free soft tissue grafts to increase the depth of the vestibule in the mandibular premolar and anterior regions. Despite the patient’s lack of smoking cessation both the donor and the recipient sites healed remarkably well. There was an absence of delayed or altered wound healing. The second report described the use of a lateral sliding flap combined with resin modified glass ionomer for the treatment of an isolated recession defect. The authors reported reduction in probing depth, gain in clinical attachment level and the presence of wide band of keratinized tissue over the restored root surface.

In the patient described in this report, the decision to use LSF was based on the severity of the recession and because free soft tissue grafts are unpredictable when attempting to cover broad denuded roots. A connective tissue graft was not feasible because an inadequate amount of keratinized tissue was present to cover the graft. Numerous studies have reported root coverage ranging from 86 to 94% when using LSF. Guinard and Cafesse reported a mean gain of 3.15 mm of keratinized tissue and 2.69 mm of root coverage which translated to 69% of root coverage at 6 months postoperatively. However, they reported an average gingival recession of 1.10 mm and a mean loss of keratinized tissue of 1.25 mm around the donor area. These results were comparable to other studies by Smuckler reporting 72% of root coverage at 9 months post surgery and Sullivan who reported an average of 3.50 mm root coverage. In our case, we achieve a 6 mm of root coverage on #27 and 8 mm on #22. This translates to 80% root coverage on #22 and 50% on #27. Importantly, we did not experience any recession at the donor sites because of the sub-marginal incision design. At the 6 month post-surgical visit, we noted stability of root coverage. Despite our best efforts to encourage meticulous oral hygiene, we noticed the presence of plaque on #27. The patient was given oral hygiene instructions and motivated to practice optimal oral hygiene.

CONCLUSION
To our knowledge, this is the first case report that demonstrates successful coverage of non-restored surfaces with severe recession defects in a non-hemophiliac HIV positive patient. We hope that this will encourage practitioners to explore other surgical periodontal treatments options for this population group.

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Edentulism is usually associated with the aging patient. However, total or partial tooth loss also affects young individuals, mainly as a result of trauma, decay, anodontia, or congenital and acquired jaw defects involving the alveolar processes. For elderly patients, the use of oral implants has become an accepted treatment modality for edentulism, and most of today’s knowledge regarding implants is based on such practice. There has been hesitation to perform implant therapy for growing children, hence few children to date have been provided with implant-supported construction. Consequently, little is known about the outcome of the osseointegration procedure in young patients, and until now only a limited number of case presentations have been reported. This article reviews the current literature to discuss the use of dental implants in growing patients and the influence of maxillary and mandibular skeletal and dental growth on the stability of those implants. It is recommended to wait for the completion of dental and skeletal growth, except for severe cases of ectodermal dysplasia.

KEY WORDS: Dental implants, Ectodermal dysplasia, Alveolar bone growth, Adolescents, Hypodontia.

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INTRODUCTION

Individuals with well known inborn craniofacial anomalies such as cleft lip and palate, apert syndrome, crouzon syndrome, hemifacial microsomia, hypohidrotic ectodermal dysplasia as well as acquired defects in the facial region resulting from trauma or tumor surgery often require extensive prosthetic intervention. Therefore, prosthodontists involved in the clinical application of new treatment methods and strategies also ought to implement their use in individuals with rare disorders and form a natural part of the treatment team in children as well as adults.¹

Treatment comprises many different treatment modalities and today often includes implant supported prosthesis as the final link in a chain of prosthetic replacement for the missing teeth.² But the use of implants in the growing individual differs significantly from implants placed in the adult patients. In adults consideration is given to bone quality and quantity, potential for function, esthetics and appliance design. In children similar considerations are required; however there is an additional factor: growth. A wide variety of changes occur, both in the dentition and the jaws of the growing patient. Only by recognizing such changes can a rational approach to implants in the growing individual be made.³

From a physiologic standpoint, the conservation of bone may be the most important reason for the use of dental implants in growing patients,⁴⁵ and it even may be beneficial in some cases to stimulate alveolar bone development.⁶ Other factors that favor implant placement in children are their excellent local blood supply, positive immunobiologic resistance and uncomplicated osseous healing.⁷

However, the use of implants in young patients creates special problems because their jaws are in a period of active, dynamic growth. Since data concerning the clinical use of implant are limited at the present time, a definite protocol for their use has not been developed, though opinions have been expressed.⁸ Clinicians should have an understanding of the potential risks involved in placing implants in jaws that are still growing and developing and consider the effect that implants have on craniofacial growth.⁹

REVIEW

Implant dentistry has evolved into a reasonably predictable treatment modality for the majority of patients. Successful integration and restoration of implants is now the expected outcome. Not many long-term studies have been published; therefore critical evaluation of present data is required.

According to smith et al.¹⁰ implant use in children with ectodermal dysplasia is a treatment of choice, since its placement in the mandibular anterior region of a 5 year old patient did not affect adjacent tooth buds. Prosthesis remodeling was performed due to implant submergence. Brugnolo et al.¹¹ noted the infraocclusion of implants placed in patients aged 13 to 14.5 years, secondary to vertical growth, and prosthesis was redesigned. Anteroposterior and transverse growth seemed not to negatively influence the implants position. Guckes et al.¹² described a case of 3-year-old patient with ectodermal dysplasia in which dental implants located in the mandible and maxilla have not moved despite growth. During the 5-year follow up, the prosthesis was remodeled to accommodate eruption of the maxillary teeth and facial growth. Kearns et al.¹³ did not find evidence of restriction to trans-
verse and sagittal growth due to implant use in children with ectodermal dysplasia. Prosthesis remodeling was necessary in some patients secondary to implant submergence. Lederman et al.7 in their 7 year follow up with a mean length of 35.5 months, reported a 90% success rate on 42 endosseous dental implants placed in 34 patients aged 9 to 18 years. There was a positive soft and osseous tissue reaction to the implants, and most of the failures occurred because of subsequent traumatic injuries sustained during the healing phase after implant placement. The major complication reported was the failure of dental implants to respond to the vertical growth of adjacent teeth and alveolus due to ankylosis.

According to OpHeji,14 implants inserted into pediatric patients do not follow the regular growth process of the craniofacial skeleton and are known to behave similar to ankylosed teeth resulting in both functional and esthetic disadvantages. Rossi and Andreasen,15 found that they could interfere with the position and the eruption of adjacent tooth germs, thus resulting in potential severe trauma of the patient. These and many other adverse effects have resulted in a very restrictive indication for dental implants in those individuals who have not completed craniofacial growth yet.14 However, there are exceptions, for instance children who suffer from extended hypodontia or even anodontia, congenital syndromes such as ectodermal dysplasia (characterized by an aplasia or dysplasia of tissues of ectodermal origin – hair, nails, skin, teeth).16 In affected patients, the extensive lack of both deciduous and permanent teeth results in atrophy and a reduced growth rate of the affected alveolar processes. Recent reports suggest that these pediatric patients can benefit remarkably from an implant-supported oral rehabilitation.

Bjork,17,18 implanted pins in the jaws of children for longitudinal cephalometric studies and reported that those in the path of erupting teeth were displaced and those placed in resorptive areas were lost. Pins placed in areas of appositional bone growth became embedded. Oesterle3 compared dental implants to ankylosed primary teeth. They wrote that ankylosis arrests both dental eruption and alveolar bone formation in the affected area. An osseointegrated implant would behave much like an ankylosed primary tooth, with the same lack of alveolar growth and dental eruption, and thus it would appear to submerge into the alveolus. The authors proposed that implants placed in the posterior maxilla in children might become buried to the point that the apical portion may become exposed as the nasal and antral floor remodel. They also warned the possibility of loss of implants in the anterior maxilla because of resorption in the infraorbital fossa and nasal floor.

In another similar study by Cronin RJ et al,19 the authors discussed rotational growth of the mandible as related to implants in children with a strong rotational growth pattern. Posterior teeth continue to erupt along with continued alveolar growth to maintain the occlusal plane, possibly causing implants to become deeply buried within the mandibular alveolar process. Children without this rotational growth would not be expected to exhibit this same submergence of implants.

**ANIMAL STUDIES**

Thailander et al.20 concluded that osseointegrated implants in pigs remained stable in place and either became buried in alveolar bone, creating a deviation of the erupting adjacent teeth, or were lost because of bone resorption. They
recommended that implants not be placed posterior to the canines during active growth. Additionally adjacent tooth germs exhibited morphologic changes and disorders of eruption.

In another similar study done by Sennery et al.\textsuperscript{21} it was shown that endosseous implants placed in young pigs have limited the effects of ankylosed teeth. Placed in alignment with adjacent teeth, the implants did not participate in growth processes, resulting in an infraocclusion and multidimensional dislocation when compared with the developing teeth.

**DISCUSSION**

The benefits of implant use in growing patients are as important as the concerns for their premature use. It is a controversial matter and not many reports have been published; therefore, an individual and careful diagnosis and treatment plan are required. As the dental implants in children are a new treatment modality, the impact that a bone-supported prosthesis might have on facial growth or, conversely, how growth might influence the longevity and esthetics of the implant prosthesis is not very clearly known.

There are 2 primary concerns, first, if implants are present during several years of facial growth, do they face a danger of becoming embedded, relocated, or displaced as the jaws grow? Any of these outcomes is possible because implants, in contrast to teeth, are not capable of compensatory eruption or other physiologic movements. Second concern is the effect of prosthesis on growth. Can a rigid prosthesis attached to implants bridging a growth area inhibit growth? As a corollary, are there design changes that must be incorporated into such prosthesis to compensate for growth changes?

Several aspects of craniofacial skeletal growth seem relevant for implant insertions in growing children with hypodontia. Both the maxilla and the mandible are dynamically changing during childhood. Behaving similar to ankylosed teeth, implants cannot participate with the maxillary growth processes of drift and displacement,\textsuperscript{22} resulting in unpredictable implant dislocations during growth or, if implants are fixed together, there are maxillary growth disturbances.

Because of the resorptive aspects of maxillary growth at the nasal floor and the anterior surface of the maxilla, unpredictable implant dislocations in vertical and anteroposterior direction can occur and even implant losses have to be expected. Transversal growth of the maxilla occurs mostly at the midpalatal suture. Consequently, fixed implant constructions crossing the midpalatal suture will result in a transversal growth restriction of the maxilla. All in all, the insertion of implants in the growing maxilla should be avoided until early adulthood.\textsuperscript{4}

In the mandible, however, the transversal skeletal or alveolodental changes are less dramatic as in the maxilla. In the posterior mandible, growth changes occur predominantly in late childhood with large amounts of anteroposterior, transverse and vertical growth.\textsuperscript{22} Additionally, the mandible undergoes rotational growth, resulting particularly in vertical alterations.\textsuperscript{22,23} When several teeth are present, vertical growth is a major aspect of dental height increase and results in anteroposterior compensatory changes in the dentition. Consequently implants would remain in an infraocclusal position and would probably be displaced in the anteroposterior direction.\textsuperscript{24} In the anterior mandible however, alveolar growth seems relatively small when teeth are miss-
The majority of the transversal growth of the mandible occurs quite early in childhood, the anteroposterior growth occurs mainly at the posterior mandible. However, in children with severe hypodontia, the anterior mandible might represent probably the most suitable site of implant placement. In the last few years, several case reports of implant insertions in the anterior mandible of children have been published. In a monocentric prospective study survival rate of implants placed in the anterior mandible of pediatric patients with ectodermal dysplasia was reported with 91%. Interestingly, some reports have demonstrated that craniofacial morphology did not differ significantly between implant treated and non treated children with ectodermal dysplasia, suggesting that treatment with intraosseous dental implants did not necessarily interrupt normal craniofacial growth, as assumed before. But, in the long run, implants located at anterior mandible probably seem affected by the mandibular growth rotation, which can result in a change in implant angulation.27

**IMPLANT TIMING**
The finding of the ideal time of implant treatment in children seems quite difficult because many different aspects have to be considered while finding the best individual treatment strategy. Nevertheless, reports in the literature describe placement of implants as early as 3 years or 5 years of age. But the safest time to place implants seems to be during the lower portion of the declining adolescent growth curve at or near adulthood that can be determined by cephalographic radiographs, serial measure of stature or handwrist radiographs.24 Other relevant aspects to consider include the individual status of the existing dentition, the functional status of mastication and phonetics, esthetic aspects and emotional psychological well being. Finally, both the parents and the child have to be compliant to implant treatment and implant hygiene.13 According to the 1988 national institute of health consensus development conference on dental implants at Bethesda, child patients with ectodermal dysplasia could benefit from the use of dental implants. The published reports about implant used in young patients are as yet very limited, and long-term clinical studies are necessary for sound conclusions. If the goals of treatment planning favors implant use before skeletal maturation, parents must be informed about benefits and possible complications, and careful attention must be given to prosthesis design.

**CONCLUSION**
1. Implant location, the sex of the patient, and the skeletal maturation level are the most important factors in the final decision of when to place implants.
2. It is still recommended to wait for the completion of dental and skeletal growth expect for severe cases of ectodermal dysplasia.

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