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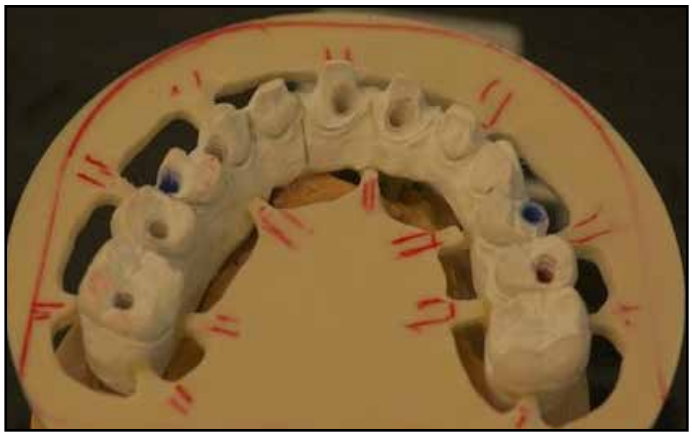

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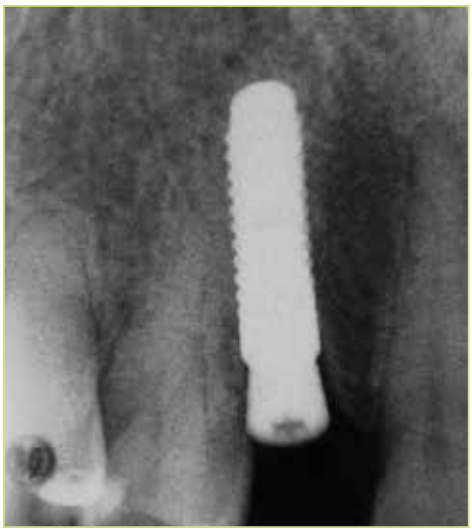

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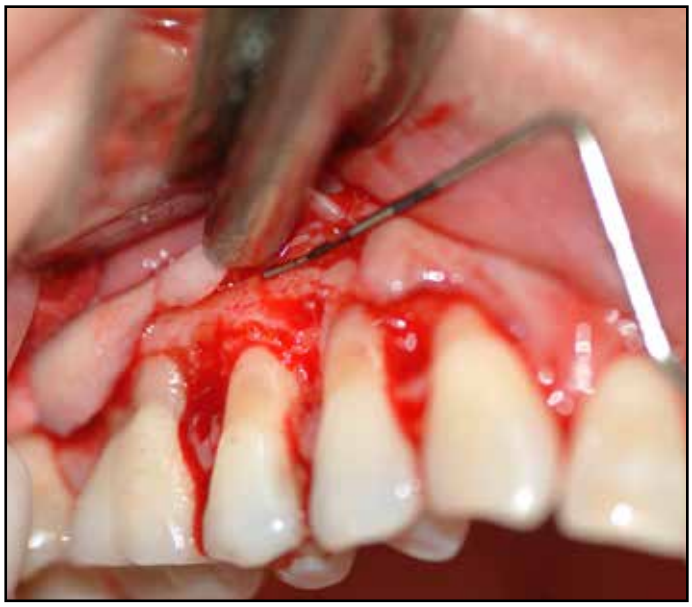

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Utilization of Autologous Concentrated Growth Factors (CGF) Enriched Bone Graft Matrix (Sticky Bone) and CGF-Enriched Fibrin Membrane in Implant Dentistry

Dong-Seok Sohn, DDS, PhD[1] • Bingzhen Huang, MD, PhD[2] • Jin Kim, DDS, MS[3]
W. Eric Park, DDS[4] • Charles C. Park DDS[5]

Abstract

Platelets are known to release several growth factors which stimulate tissue regeneration. Several techniques for platelet concentrates have been introduced in surgical field for the prevention of hemorrhage and acceleration of tissue regeneration. Platelet rich plasma (PRP) and plasma rich in growth factors (PRGF) belong to the first generation of platelet concentrates. PRP and PRGF require chemical additives such as anticoagulants and thrombin or calcium chloride to induce fibrin polymerization before applying to the surgical site. Platelet rich fibrin (PRF) and concentrated growth factors (CGF), as second generation of platelet concentrate, utilizes patient's venous blood alone to trigger platelet activation and fibrin polymerization. PRF and CGF can be used as alternative to traditional barrier membrane over bone graft, therefore acceleration of tissue regeneration is acquired. Unlike PRF using constant centrifugation speed, CGF utilizes altered centrifugation speed to produce much larger, denser and richer fibrin matrix containing growth factors. A new concept of fabricating growth factors-enriched bone graft matrix (also known as "sticky bone") using autologous fibrin glue has been demonstrated since 2010. Sticky bone provides stabilization of bone graft in the defect, and therefore, accelerates tissue healing and minimizes bone loss during healing period. This report presents the method of preparing and utilizing CGF and sticky bone, and clinical cases that support its use.

KEY WORDS: Concentrated growth factors, platelet rich fibrin, ridge augmentation, growth factors-enriched bone graft, sticky bone. guided bone regeneration

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Figure 1: Patient's venous blood taken from patients' vein in patient's forearm is divided into two types of vacutainers without anticoagulant. Non-coated test tubes (yellow cap) are used to obtain AFG, which will make sticky bone and glass coated test tubes (red cap), is used to obtain CGF layer.

Figure 2: A specific centrifuge with a rotor turning at alternated and controlled speed from 2,400 to 2,700 rpm for 12 minutes.

INTRODUCTION

Implant supported dental restorations have become a major option in the treatment of edentulous alveolar ridge for the past several decades. Extensive loss of alveolar bone presents a complex challenge for reconstruction. Numerous augmentation techniques are currently in use to create sufficient bone volume for reliable placement of endosseous implants in severely resorbed edentulous alveolar ridges.[1] In order to accelerate healing of bone graft over the bony defect, numerous techniques utilizing platelet and fibrinogen concentrations have been introduced in the literature. Platelet is known to contain high quantities of growth factors, such as transforming growth factors ß-1 (TGFß-1), platelet-derived growth factor (PDGF), epithelial growth factor (EGF), insulin growth factor-I (IFG-I) and vascular endothelial growth factors (VEGF), which stimulates cell proliferation and up regulates angiogenesis.[2-4]

Platelet rich plasma (PRP) is the first form of autologous platelet concentrate to replace commercial fibrin glue.[5,6] Small amount of PRP is prepared in dental office for use in clinical implant dentistry. Numerous PRP kits, such as the Platelet Concentrated Collection System (PCCS; 3i/Implant Innovations, Palm Beach Gardens, FL),

Figure 3: Silica coated red cap tube shows three different layers after centrifugation. The most upper layer is platelet poor plasma, and the middle layer is fibrin buffy coat layer represented by a very large and dense polymerized fibrin block containing the concentrated growth factors. The bottom layer is red blood cell layer. Non-coated yellow cap tube shows two different layers. The upper layer is AFG layer and the bottom layer is accumulation of red blood cell is which will be is discarded.

Figure 4: CGF layer placed in the sterilized metal storage box before compression. This layer is utilized for sinus augmentation as alternative to bone graft

Figure 5: CGF membrane after compressing with metal cover. This membrane is used barrier membrane as alternative to collagen membrane and is used as alternative connective tissue graft for covering exposed root.

SmartPReP (Harvest Autologius Hemobiologics, Norwell, Massachusetts), Curasan PRP kit (Curasan, Pharma Gmbh AG, Lindigstrab, Germany) and Placon (Oscotec Co, Chunan, Korea), are available in the current dental market. Preparation methods for all commercially available systems are somewhat similar. Relatively small amount of patient's venous blood (8-10cc) is drawn via venipuncture, and the blood is collected in collection tube that contains a chemical anticoagulant. Red cell layer is discarded after first centrifugation, and the buffy coat layer and platelet-poor plasma is collected in a new test tube for second centrifugation. Concentrated platelet with fibrinogen is obtained as a result of the second spin. PRP is mixed with particulate

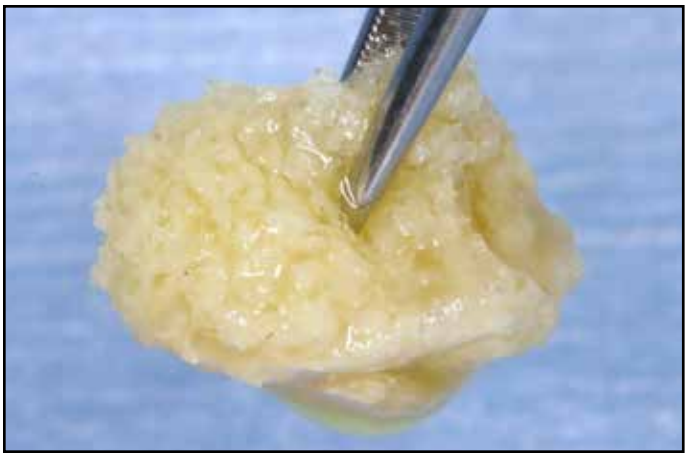

Figure 6: Yellow colored sticky bone mixed with AFG particulate bone powder. It takes 5-10 minutes for polymerization depending on types of bone graft.

bone powder, and bovine thrombin and calcium chloride is added to achieve fibrin polymerization. Anitua's plasma rich in growth factors (PRGF) is obtained by a very similar method as in the PRP protocol. PRGF needs calcium chloride to obtain fibrin polymerization.[7] PRP and PRGF are considered to be the first generation of platelet aggregates, characterized by double centrifugation, and use of chemical additives such as anticoagulants, bovine thrombin, and/or calcium chloride. Their effect on bone regeneration is still controversial.[8]

Second generation of platelet aggregate utilizes patient's venous blood alone. Choukroun's platelet-rich fibrin (PRF) is the first development of such second generation platelet aggregates.[9] Venous blood is drawn from patient's vein and collected in silica-coated Vacutainers without anticoagulants. The Vacutainers are immediately centrifuged at 2,700 rpm for 12 minutes. A natural coagulation of fibrin layer is obtained with separation of the red blood cell layer, platelet-rich fibrin can be easily collected from the tube. Sacco's concentrated growth factors (CGF) utilizes altered centrifugation from 2,400 – 2,700 rpm for 12 minutes to obtain much larger, denser and richer growth factors fibrin matrix.[10,11] PRF or CGF layers contain concentrated autologous growth factors, but it has limited utilization for ridge augmentation as PRF/CGF layer cannot stabilize particulate or powder bone, unlike the first generation aggregates, PRP/PRGF. The aim of this report is to introduce easy and predictable ridge and sinus augmentation technique utilizing CGF membrane and growth factors-enriched bone graft matrix (Sticky Bone™).

Figure 7: Red colored sticky bone. For acceleration of polymerization of sticky bone, when exudate taken after compression of CGF layer is added, auto-polymerization is usually completed within 1 minute.

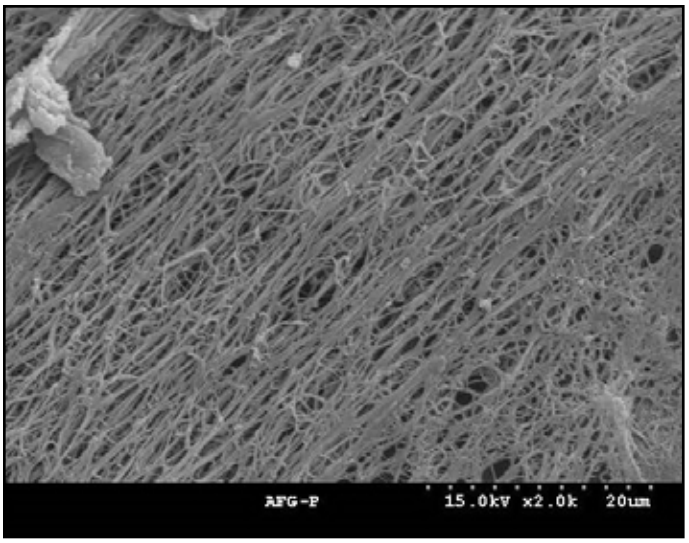

Figure 8: SEM image showing strongly interlocked fibrin network of sticky bone.

THE PREPARATION OF CGF MEMBRANE AND "STICKY BONE"

CGF membrane and autologous fibrin glue (AFG) to make sticky bone is prepared at the same time. Before ridge and/or sinus augmentation surgery is performed, 20-60CC of patient's venous blood is taken from patients' vein in patient's forearm, and the blood is divided to one to two non-coated vacutainers (yellow cap as shown on Fig 1) to obtain autologous fibrin glue (AFG), which will make sticky bone and two to seven glass coated test tubes (red cap as shown on Fig 1) without anticoagulants to obtain CGF layer (Fig 1). The blood in the test tubes is centrifuged at 2400-2700 rpm using specific centrifuge (Medifuge, Silfradent srl, Sofia, Italy or any other compatible devices) with a rotor turning at alternated and controlled speed for 12 minutes (Fig 2). The centrifugation time for AFG varies from 2-12 minutes. To get higher growth factors, the centrifuge is stopped after 2 minute-centrifugation and take AFG tube out of the centrifuge first. The non-coated tube shows 2 different layers. The upper layer is autologous fibrin glue (AFG) layer and red blood cell is collected in bottom layer which will be is discarded. The vacant slot is filled with water filled test tube for weight balance and continued centrifugation to prepare CGF. After centrifugation, silica coated tube shows three different layers. The most upper layer is platelet poor plasma, and the middle layer is fibrin buffy coat layer represented by a very large and dense polymerised fibrin block containing the concentrated growth factors. The bottom layer is red blood cell layer (Fig 3). CGF is taken in test tube and placed in the metal storage box and compress with metal cover to convert to CGF membrane (Figs 3-5).

The upper AFG is obtained with syringe and mixed with particulate bone powder and allows for 5-10 minutes for polymerization in order to produce sticky bone which is yellow colored (Fig 6). For acceleration of polymerization of AFG, exudate taken in the bottom of metal storage box after compression of CGF layer is added when AFG and particulate bone graft is mixed. The exudate contains growth factors and autologous thrombin in RBC layer, therefore auto-polymerization will be completed very rapidly. The sticky bone mixed with autologous thrombin in RBC layer shows red in color (Fig 7). This sticky bone doesn't migrate even shaking it thanks to strongly interlinked fibrin network, so the bone loss on the defect during healing period is minimized without use of bone tack or titanium mesh (Fig 8).

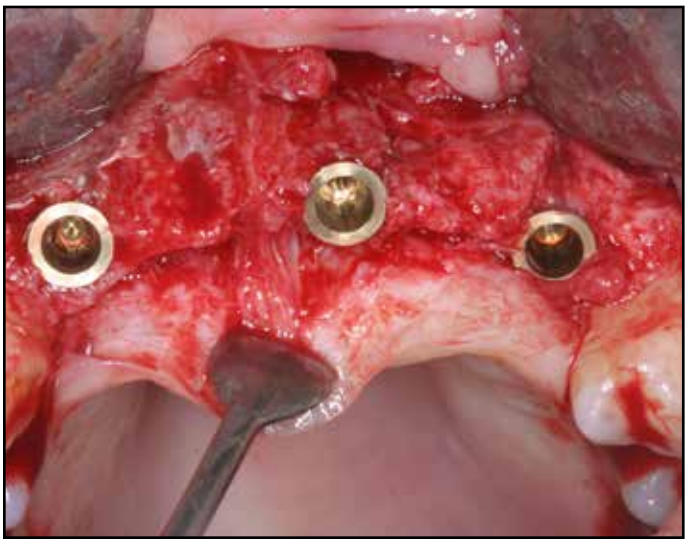

Figure 9: Note horizontal bone deficiency after implant placement. Left site shows more larger deficiency than right edentulous area.

Figure 10: Mineral allograft (BioTis, Bone Bank, BioTis Co, Seoul) saturated with exudate taken from compressed CGF was grafted on the bony defect.

Case report 1: Comparison of CGF Membrane and Collagen Membrane

A 39 year old female patient presented with missing teeth #7, #8, #9, #10. She wanted implant supported fixed restoration. Prophylactic oral antibiotics, Cefditoren pivoxil (Meiact®; Boryung Parm.,Seoul, Korea) 300mg t.i.d. were used routinely, beginning one day prior to the procedure and continuing for five days. Implant site was exposed under local anesthesia with no intravenous sedation. Implants (Biocer implant, OMT GmbH, Lübeck, Germany) were placed at the site of tooth numbers #7, #9 and #11, and horizontal bone deficiency was seen. Mineral allograft (BioTis, Bobe Bank, BioTis Co, Seoul) was mixed with exudate taken from compressed CGF and grafted on horizontal bony defect and a collagen membrane (Pericardium, Zimmer Dental, CA) was covered on the right side and two CGF membrane was covered on the left augmented site (Figs 9-11). Tension free primary suture was placed. Bone graft site was surgically re-entered after a 6-month healing period, and favorable ridge augmentation was seen at the both augmented site. To compare both augmented sites using collagen membrane and CGF membrane, bone biopsy using 2mm wide trephine bur was taken at the buccal wall of both sites (Fig 12). The specimens was fixed with 4% paraformaldehyde for 24 hours, and washed with 0.1M phosphoric buffered solution and decalcified with 10% formic acid for five days. The specimen was embedded in paraffin (Paraplast®, Oxford, USA), and sliced coronally into serial sections about 5 thick. The specimens were stained with Hematoxylin-Eosin (H-E) stains, and examined under light microscopy to verify newly-formed bone. Both specimens reveals favorable new bone formation along mineral allograft without sign of inflammation (Fig 13, 14). Esthetic final results have been maintained after 2 years follow up (Figs 15-17).

Figure 11: A collagen was covered on the right augmented site and two CGF membrane was covered on the left augmented site.

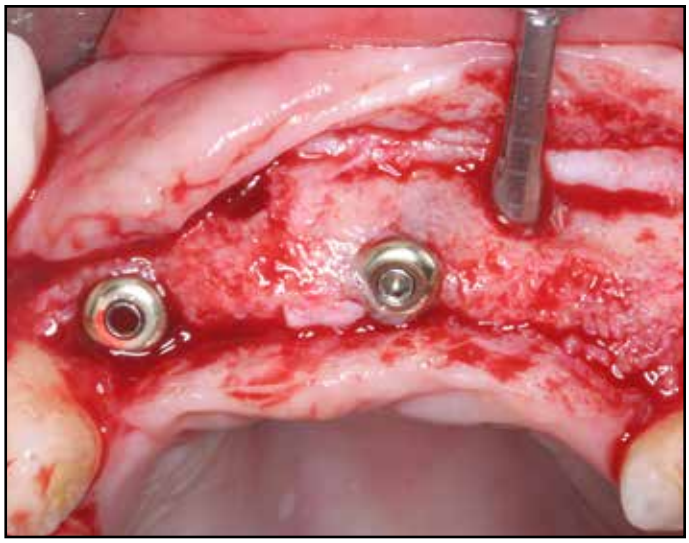

Figure 12: Reentry was done after a 6-month healing period. Favorable ridge augmentation was seen at the both augmented site. To compare both augmented sites using collagen membrane and CGF membrane histologically, bone biopsy core using 2mm wide trephine bur was taken at the buccal wall of both sites.

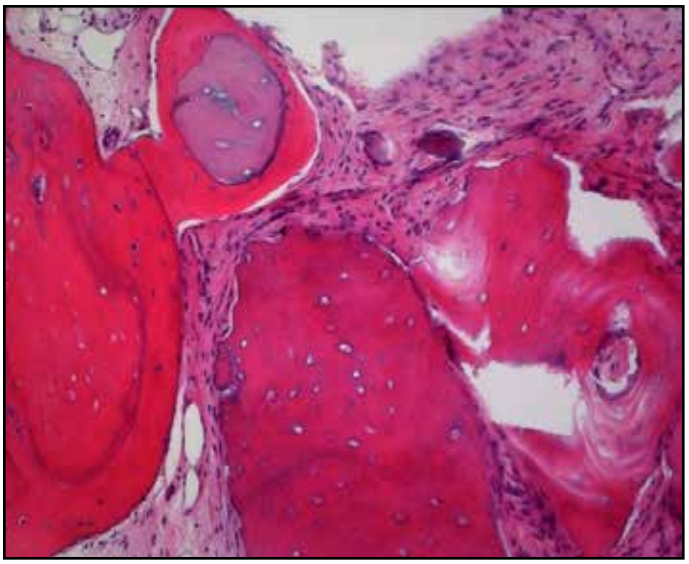

Figure 13: Biopsy in left augmented site shows newly formed bone along mineral allograft. Hematoxylin-Eosin (H-E) stains (X100).

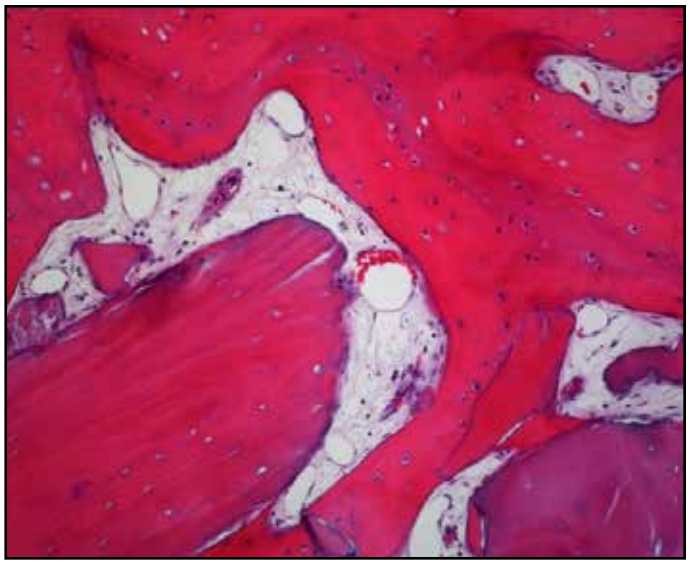

Figure 14: Biopsy in right augmented site shows favorable new bone formation along mineral allograft without sign of inflammation.. Hematoxylin-Eosin (H-E) stains (X100).

Figure 15: Esthetic final result in 2 years follow up.

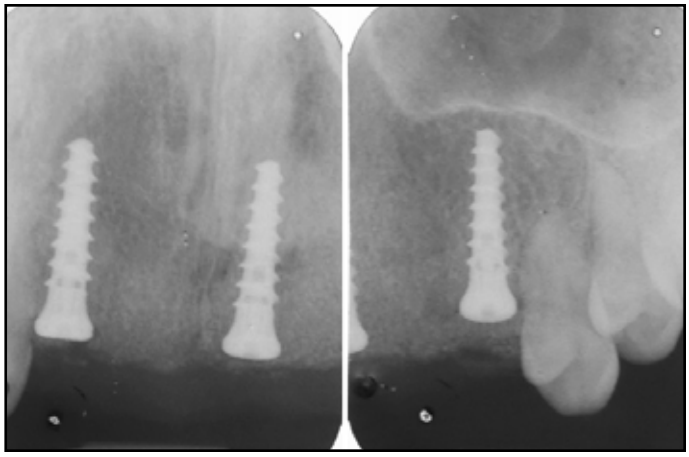

Figure 16: A postoperative periapical radiograph.

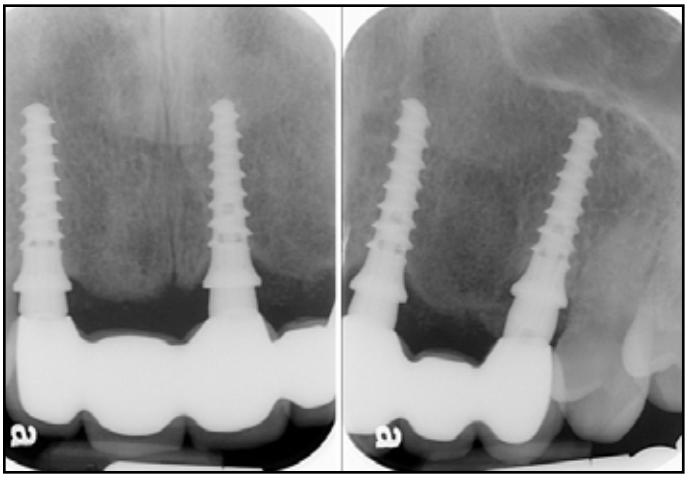

Figure 17: A periapical radiograph in 2 years function reveals stable bone maintenance.

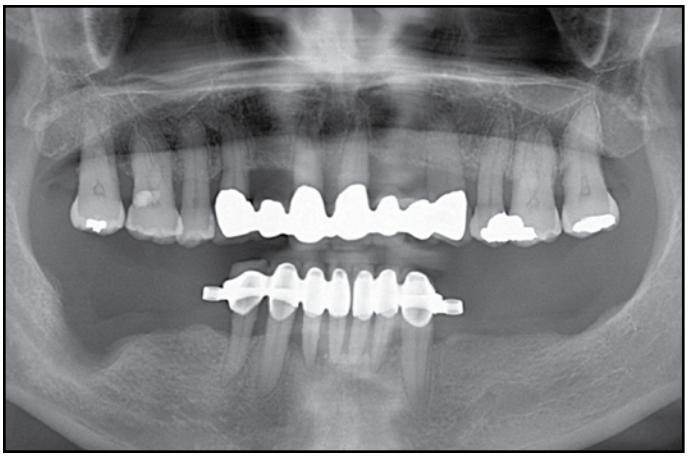

Figure 18: A plain radiograph reveals sever vertical bony deficiency on the right posterior mandible.

Figure 19: Prepared sticky bone using bovine and mineral allograft.

Case 2: Three Dimensional Ridge Augmentation using Sticky bone with/ without Titanium Mesh

A 45-year-old male patient with a complaint of masticatory difficulty was referred from private dental clinic for the ridge augmentation and implant placement. Radiographic and clinical examination revealed severe vertical and horizontal ridge resorption on the right mandibular edentulous ridge and severe horizontal ridge deficiency on the left the mandibular edentulous ridge (Fig 18). Sticky bone was prepared as described above before surgery (Fig 19). The surgery was performed under the local anesthesia through maxillary block anesthesia by using 2% lidocaine that includes 1:100,000 epinephrine. Full thickness mucoperiosteal flap was elevated to expose the both implant sites. Right edentulous posterior area showed severe vertical defect and narrow (2-3mm wide) alveolar ridge. Three implants (Dentis implant Co, Daegu, Korea) were placed at the sites of tooth numbers #29, #30, and 31 with good stability. Exposure of implant surface was shown at the site of #30 and #31. Prepared sticky bone using bovine bone (Biocera, Oscotec Co, Chunan, Korea) and mineral allograft (Puros allograft, Zimmer Dental, CA) was grafted over the exposed implant surface and boney defect for 3-dimentional ridge augmentation, and resorbable collagen membrane (Pericardium, Zimmer Dental, CA) alone was covered over the bone graft (Figs 19-22). The left edentulous ridge revealed sever horizontal deficiency. Three implants were placed at the sites corresponding to tooth numbers #18, #19, and 20 with good stability, and severe exposure of implants was shown. Particulate bone graft was placed on the defect and titanium mesh (Neo implant Co, Seoul, Kora) was covered to stabilize particulate bone graft. Three CGF membrane was covered over the bone graft and mesh (Figs 23-25). Implants were exposed after 4months healing. Favorable 3-dimentional ridge augmentation was observed on the right area even titanium mesh was not used because sticky bone didn't migrate during healing period. Favorable horizontal ridge augmentation was observed on the left site. The patient came back to her dentist for prosthetic restoration (Figs 27-29).

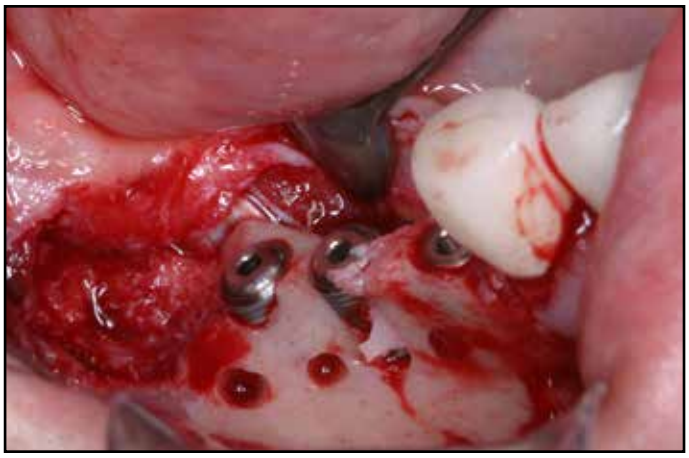

Figure 20: Note severe exposure of implant surface after implant placement and vertical bone defect.

Figure 21: Sticky bone was grafted on the exposed implant surface and bony defect for 3-dimentional ridge augmentation.

Figure 22: A resorbable collagen membrane alone was covered over the bone graft without additional bone stabilization procedure.

Figure 23: Note sever exposure of implant surface on the edentulous left posterior mandible.

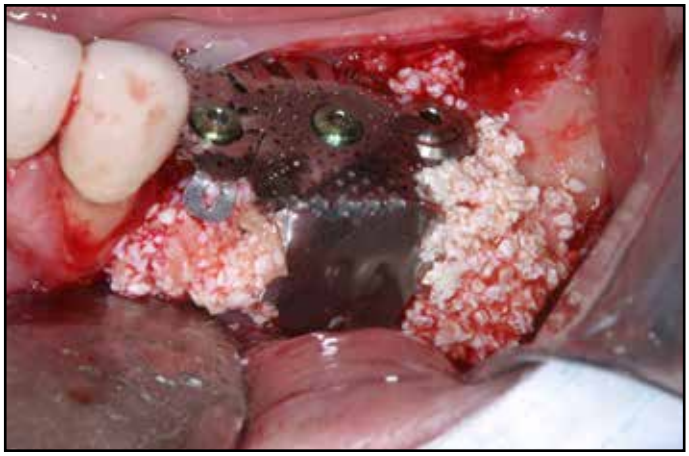

Figure 24: Sticky bone was not prepared, so particulate bone graft was placed on the defect and customized titanium mesh (Neo implant Co, Seoul, Kora) was utilized to stabilize particulate bone graft.

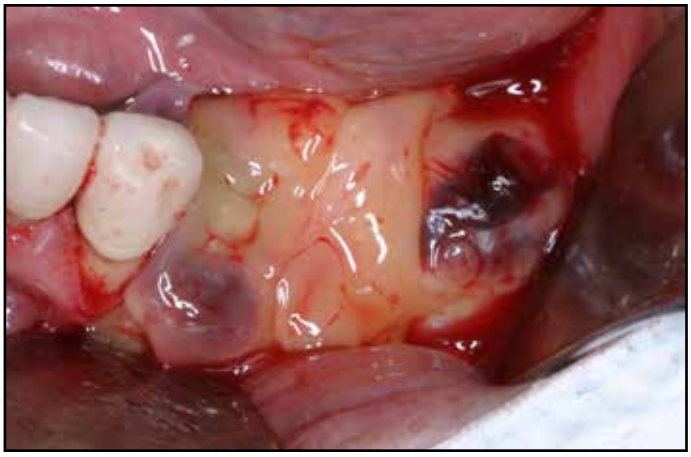

Figure 25: Three CGF membrane was covered over the bone graft and mesh to accelerate tissue regeneration.

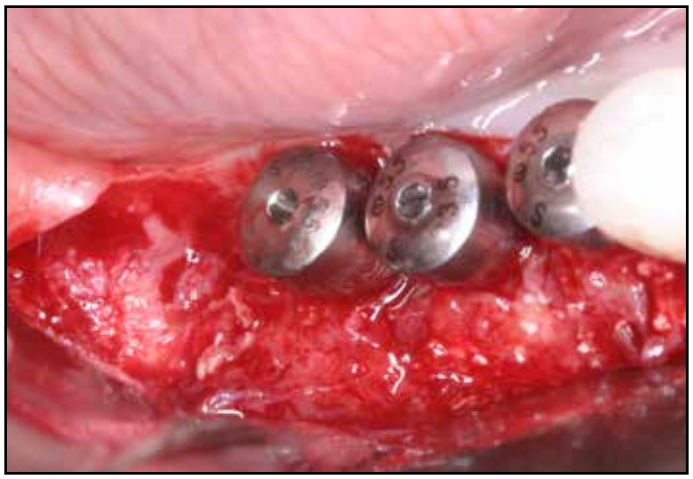

Figure 26: Note favorable 3-dimentional ridge augmentation after 4 months healing on the right site. Sticky bone didn't migrate even grafted for three dimensional augmentation without use of additional bone graft stabilization materials.

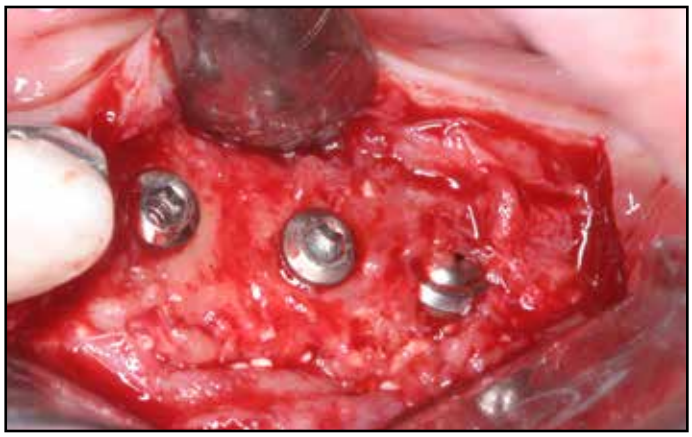

Figure 28: A postoperative periapical radiograph (left) and radiograph (right) after uncovering on the right site.

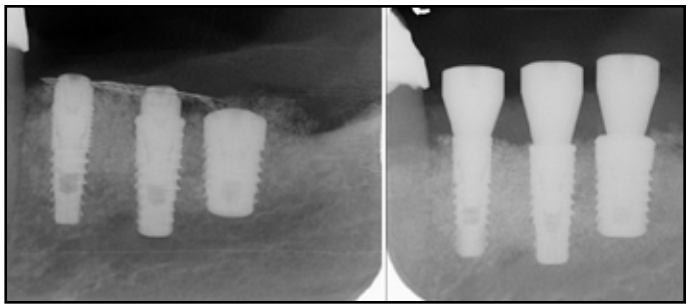

Figure 29: A postoperative periapical radiograph (left) and radiograph (right) after uncovering on the right site.

Case 3: Minimally Invasive Horizontal Ridge Augmentation using Sticky Bone and Tunnel Technique

A 49 year old female patient visited at our department with complaint of masticatory difficulty and esthetic problem. She has suffered from chronic periodontitis in whole dentition and showed the missing of upper two central incisors (Figs 30, 31). The hopeless upper right and left lateral incisor and left canine were extracted under local anesthesia. Three implants (MIS Implant, Israel) were placed immediately. Labial fenestration defect was verified in the all implant sites through the vertical releasing incision which was made in buccal mucosa adjacent to implant site. Sticky bone prepared with bovine bone (Biocera, Oscotec Co, Chunan, Korea) and mineral allograft (Puros allograft, Zimmer Dental, CA) was grafted over the exposed implant surface through the vertical incision. Collagen membrane or titanium mesh was not used to stabilize bone graft (Figs 32-35). After closing of incision area in edentulous anterior maxilla, hopeless upper right second premolar and first and second molar were extracted in order to perform sinus augmentation and simultaneous implant placement. Osteoinductive replaceable bone window was prepared with a thin bladed saw insert (S-Saw, Bukboo Dental Co., Daegu, Korea), connected to piezoelectric devices (Surgybone®, Silfradent srl, Sofia, Italy) to access sinus cavity. The bony window was detached from sinus membrane and sinus membrane elevation was performed carefully. Four pieces of CGF was inserted in the new compartment under the elevated sinus mucosa and three implants were placed immediately at the sites corresponding to tooth numbers #13, #14 and #15. The detached bony window was repositioned and particulate bovine bone was grafted in the extract defect and collagen membrane was covered over the bone graft to prevent soft tissue invasion and stabilize particulate bone graft (Figs 36-41). Immediate temporary restoration on anterior implant was delivered on the next day. Final ceramic restoration was cemented in all implant sites after 6 months healing. The cross sectional image of cone beam computed tomogram shows stable bone augmentation over the exposed implant surface after 1 year loading (Figs 42-46).

Figure 30: Preoperative intraoral view reveals the missing of upper two central incisors and chronic periodontitis in whole dentition.

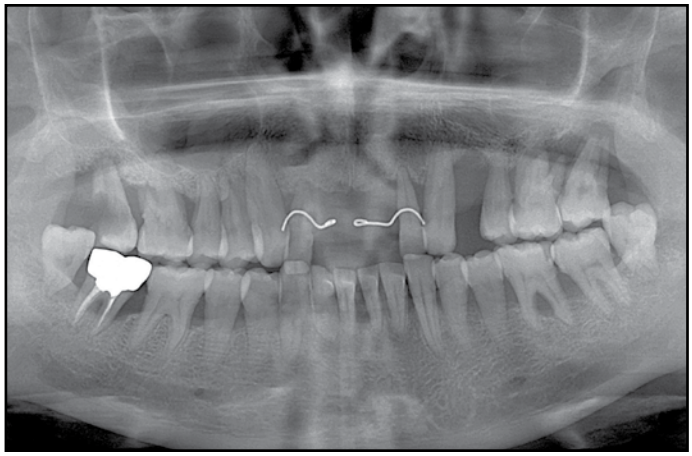

Figure 31: Preoperative intraoral image reveals chronic periodontitis with severe bone resorption in entire dentition.

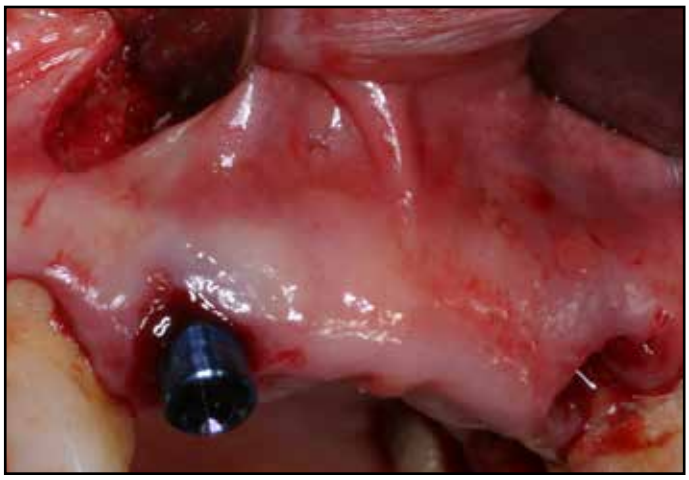

Figure 32: A pain radiograph reveals severe alveolar bone resorption in entire dentition.

Figure 33: Implants were placed immediately after extraction of upper right and left lateral incisor and left canine. Dehiscence defect was detected on implant site corresponding to right lateral incisor.

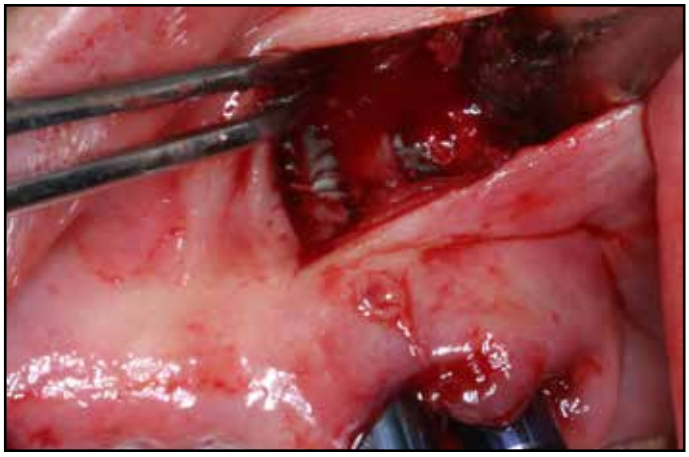

Figure 34: Labial fenestration defect was verified in implants corresponding to tooth number #10 and #11.

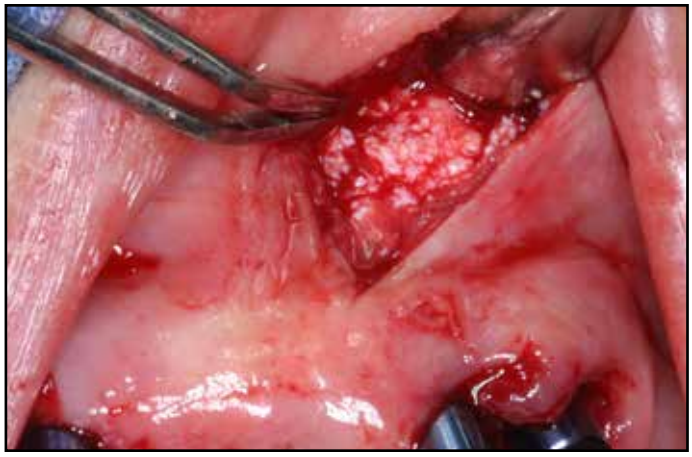

Figure 35: Prepared sticky bone was grafted over the exposed implant surface by tunnel technique. Any barrier membrane was not utilized.

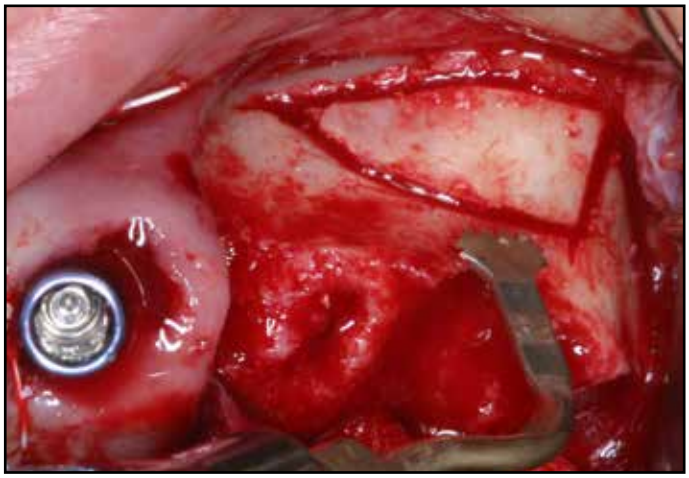

Figure 36: After extraction of hopeless upper right second premolar and first and second molar, laterally approached sinus augmentation was performed. Osteoinductive replaceable bone window was prepared with a thin bladed saw insert to access sinus cavity.

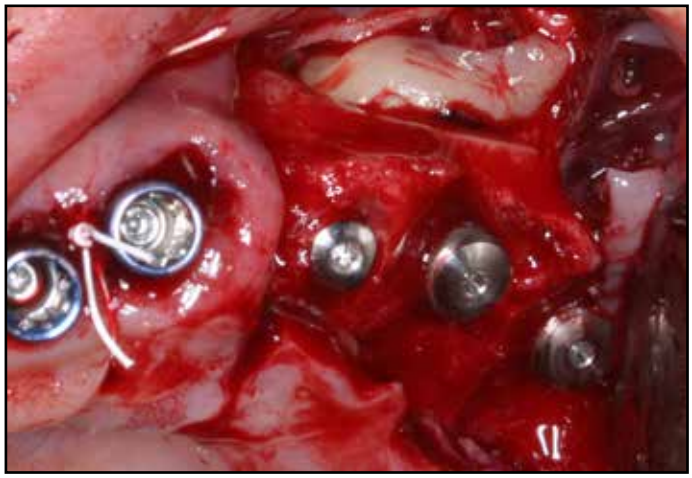

Figure 37: Sinus membrane was elevated carefully after detachment of the bony window.

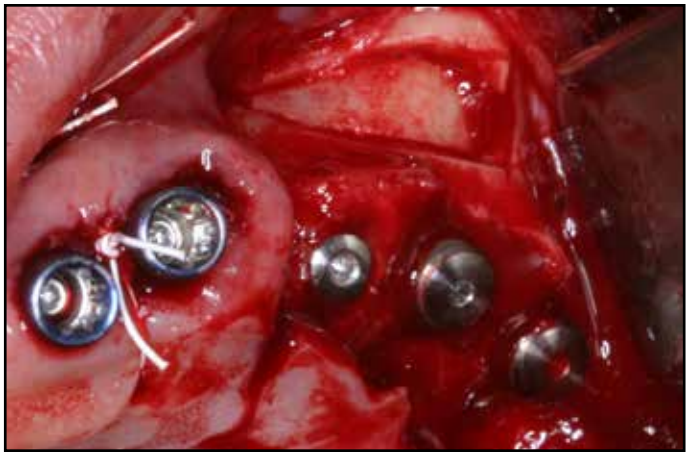

Figure 38: Four pieces of CGF was inserted in the sinus and implants were placed simultaneously at the site of tooth numbers of #13, #14 and #15. The detached bony window was repositioned.

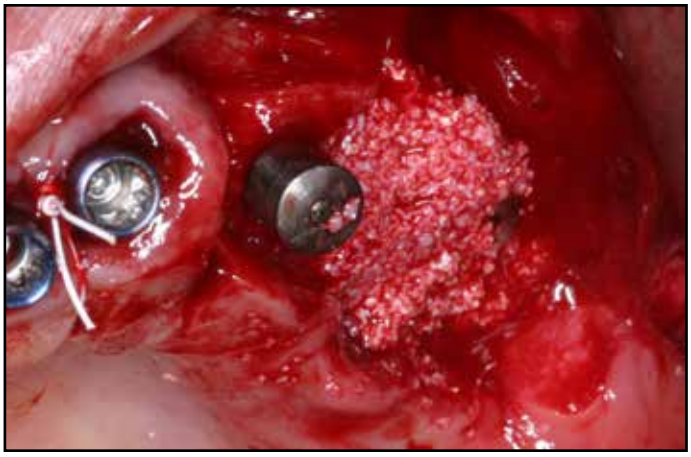

Figure 39: Particulate bovine bone was grafted in the extraction defect and collagen membrane was covered over the bone graft.

Figure 40: Particulate bovine bone was grafted in the extract defect and collagen membrane was covered over the bone graft to prevent soft tissue invasion and stabilize particulate bone graft.

Figure 41: Immediate temporary restoration on upper anterior implant sites.

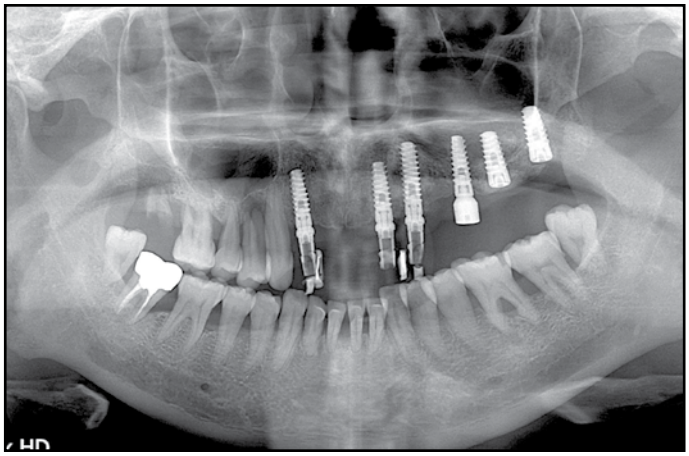

Figure 42: Postoperative radiograph.

Figure 43: Final ceramic restoration was cemented after 6 months healing.

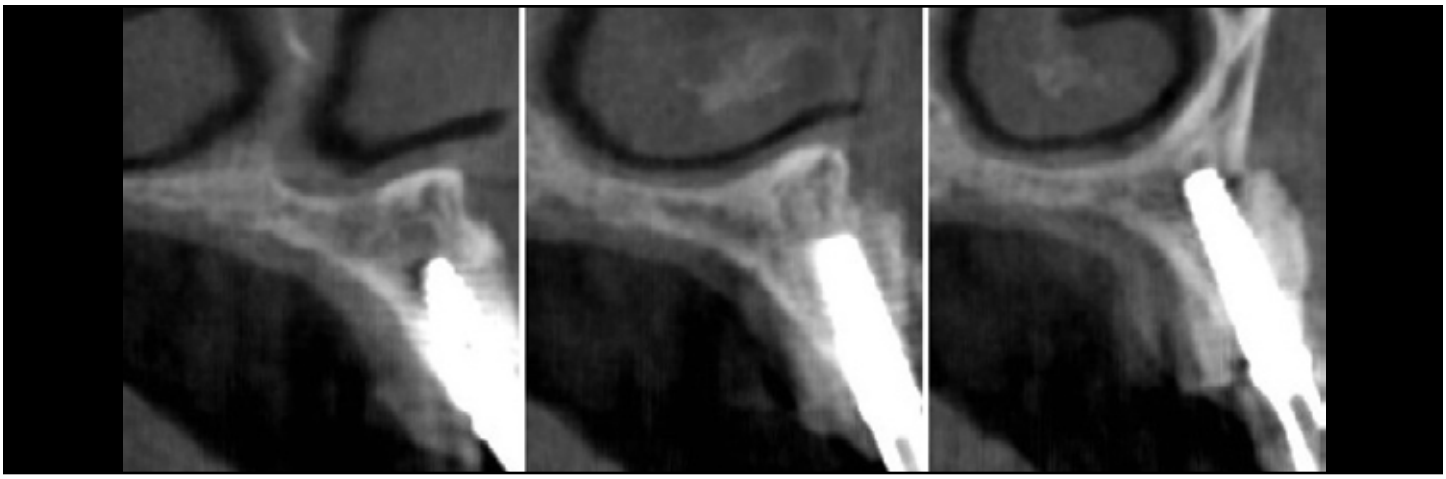

Figure 44: The cross sectional image of CBCT reveals stable bone augmentation over the exposed implant surface after 1 year loading.

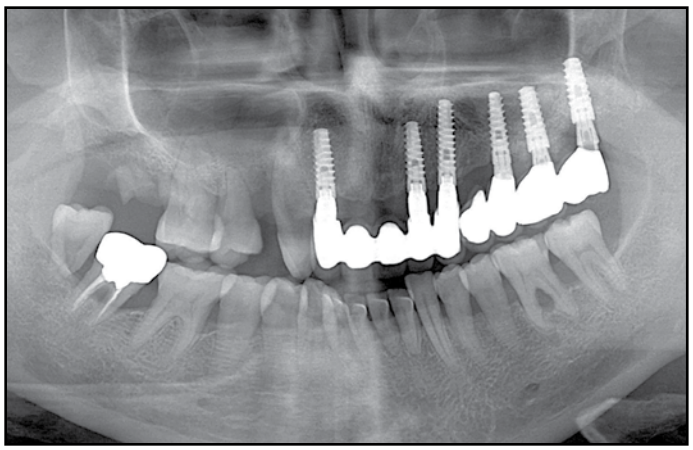

Figure 45: A plain radiograoh after 1 year in function. Note sinus augmentation with CGF alone.

DISCUSSION

Platelets are known to release high quantities of growth factors such as platelet-derived growth factor (PDGF), trans- forming growth factor-b1 (TGF-b1) and b2 (TGF-b2), fibroblast growth factor (FGF), vascular endothelial growth factor (VEGF), and insulin-like growth factor (IGF), which stimulate cell proliferation, matrix remodeling, and angiogenesis.[12] Several techniques to collect platelet aggregate have been utilized to accelerate tissue healing in dental and medical field.[6-10] Choukron's PRF and Sacco's CGF are recently developed platelet aggregation. These two methods collect leukocyte and platelet rich fibrin gel using a natural coagulation process. Compared to PRP and PRGF, PRF and CGF are simple to make and doesn't require any synthetic or biomaterials, such as bovine thrombin and calcium chloride, to make gel condition. So it is free from the risk of cross-contamination.[13] Fibrin rich gel is known to release slowly growth factors such as transforming growth factor, platelet-derived growth factor and vascular endothelial growth factor and accelerates new bone formation when it mixed with bone graft in the maxillary sinus.[14,15] You et al. reported that platelet rich fibrin gel can induce higher bone to implant contact than platelet rich plasma in bony defect around dental implant.[16]

Unlike PRF using constant centrifugation, CGF utilize altered centrifugation speed from 2,400-2,700 rpm to isolate much larger, denser and richer in growth factors enriched fibrin matrix.[11] As alternative to bone substitutes, growth factors enriched fibrin gel revealed active new bone formation in the maxillary sinus without complication of postoperative infection.[17-21] PRF and CGF in a compressed membrane-like form has also been used as a substitute for commercially available collagen barrier membranes in guided bone regeneration to improve tissue healing.[22,23]

Atrophic alveolar ridge is a challenging site to place implant. Guided bone regeneration (GBR) using bone graft and barrier membrane is a well-established technique for augmentation of atrophic alveolar ridges.[24-26] For successful GBR, stability of bone graft, space maintenance, angiogenesis, and tension free primary suture are essential.[26,27] Space maintenance with particulate bone graft should be provided during healing period. However particulate bone graft is easily migrated when grafted on the large horizontal/vertical bone defect. To reconstruct large one or two wall bony defect or for the 3-dimensional ridge augmentation, bone tack on the collagen membrane or titanium mesh is required to contain particulate bone graft during healing but these procedures are surgically time consuming and technique sensitive. In addition, the early exposure of titanium mesh causes bone loss and infection which causes failure of bone augmentation.[28,29] For solid space maintenance in the severely atrophic alveolar ridge, block bone graft procedure is widely accepted but this technique has several disadvantages such as early exposure of bone graft, neurosensory disturbance, increased patient's postoperative discomfort and surgical cost, delayed surgical time and additional surgery from donor site.[30, 31]

As alternative to titanium mesh or block bone procedure, sticky bone was introduced in 2010 by authors.[32] Sticky bone is biologically solidified bone graft which is entrapped in fibrin network. Sticky bone graft doesn't scatter even

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upon being shaken with cotton plier because particulate bone powders are strongly interconnected each other by fibrin network. Sticky bone has numerous advantages: 1) it is moldable, so well adapted over various shape of bony defect; 2) Micro and macro movement of grafted bone is prevented. So the volume of augmentation is maintained during healing period, therefore the need of block bone and titanium mesh is minimized; 3) Fibrin network entraps platelets and leukocytes to release growth factors, so bone regeneration and soft tissue is accelerated; 4) No biochemical additives are needed to make sticky bone unlike PRP or PRGF; 5) Fibrin interconnection minimizes soft tissue ingrowth into the sticky bone graft.

CONCLUSION

CGF membrane and sticky bone is easy to make and they are a very effective materials for the reconstruction of edentulous alveolar bone defect, based on the concept of minimally invasiveness on ridge augmentation. Further clinical study is needed.

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

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A New Paradigm for Fixed Complete Dentures

Paul P. Binon DDS, MSD[1] • Henning Visser MDT[2]

Abstract

The ever expanding role of Zirconia is applied to one piece full arch implant supported restorations that mirror their metal counterpart in strength and versatility and exceeds them in complete passivity at the implant interface. Their overall natural appearance and refined esthetic is limited only by the mastery of the dentist / technician team that applies this new technology. The clinical and laboratory sequence of the prosthesis creation is presented from start to completion.

KEY WORDS: Dentures, prosthetics, fixed complete dentures, dental implants

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2. Master Technician, CEO/President Vitalab Dental Laboratory

Figure 1: Pretreatment bridge.

Figure 2: Master cast. New implants placed in sites 2, 3, 5, 8, 9, and 11. Both the new implants and the original implants in sites 4, 12, 13 and 14 had universal conical type of abutments placed.

INTRODUCTION

For those patients that demand a higher level of function, comfort and esthetics than that offered by conventional complete dentures, numerous options have become available since the advent of osseointegrated implants. Implant supported prosthetics options include: ceramo metal fixed bridges, metal acrylic fixed dentures, and milled or cast bars with a variety of retentive elements.[1,2] In each of these restorations, the metal framework or substructure is typically fabricated using the lost wax technique. Large spans of this type have inherent issues with passivity on seating. More recently milled bars have been created with aid of CAD/CAM technology and the joining of the respective components with laser welding in efforts to eliminate these limitations.[3] In each of the prosthesis noted above, a metallic structure is still involved as its central core.

The introduction of breakthrough CAD/CAM technology by the three independent groups Normann & Brandestini, Duret and Rekow in the late 1970's has led to practical clinical applications that have continued to be refined. They resulted in commercial successful applications such as Cerec, Cynovad and Bego that create computer based restorations in titanium and ceramic materials. A more direct mechanical data acquisition method that is directly connected to a mechanical miller was introduced in 1990 by Eidenbenz. Additional direct copy- systems were introduced by Ceramatic and Krupp Medizintechnikin in Europe in the mid 1990's. Shortly thereafter (2005) E. Steger (ZirkonZahn) introduced the Zirkograph for direct copy milling of Zirconia.[4] Unlike most other CAD/CAM systems, the Zirkograph is unique in its 5 + 1 axis milling capability, allowing it to replicate very complex structures.

During the same time period, significant progress was made in the use of pressed ceramic and Zirconia restorations for tooth supported single and multi-unit fixed bridgework.[5,6] That same

Figure 3: Full contour diagnostic wax up on articulated cast. Note the amount of pink wax representing soft tissue. This indicates clearly that this should be a profile type of fixed prosthesis.

Figure 4: Duplicated epoxy teeth are set up on the master cast with the cast to cylinders attached to the implant abutments. The soft tissue space is replicated in pink wax.

Figure 5a: Duplicated wax up poured in PolyDie material with cast to cylinders in place. 5 A Shows the occlusal surface with the screw access holes visible.

Figure 5b: Duplicated wax up poured in PolyDie material with cast to cylinders in place. 5 B Shows the intaglio surface of the model with the cylinder / abutment mating surfaces.

technology has been explored and applied to milled bars and complete all Zirconia one piece fixed complete dentures.[7,8] Studies have demonstrated the excellent chemical/physical properties of zirconium oxide, its strength, reliability, inhibition of plaque formation and its ideal optical appearance.[9,10] Milled Zirconia offers an unlimited plethora of prosthetic applications and an ideal

Figure 6: Model is modified with veneer and/or full coverage preparations in the anterior segment before it is copy milled in the Zirkograph.

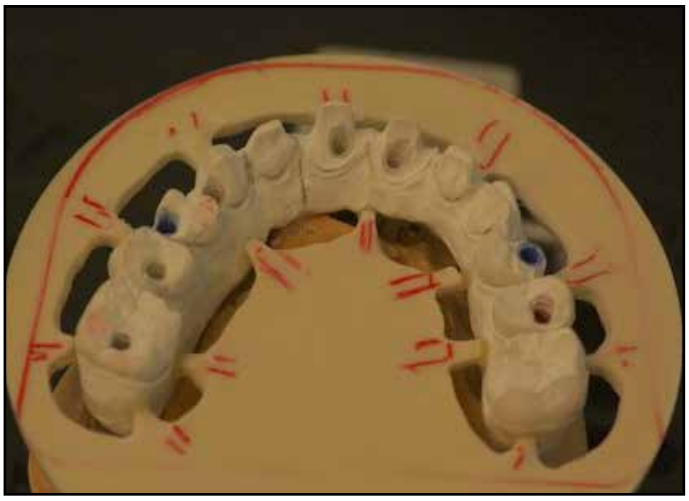

Figure 7a: The outline of the model is the marked and cut out of the polyurethane disc, leaving multiple support elements. 7A shows the resultant mounted casts occlusal surface.

Figure 7b: The outline of the model is the marked and cut out of the polyurethane disc, leaving multiple support elements. Figure 7B shows the intaglio surface.

Figure 8: Zirkograph is composed of two mounting ring that allow 5 axis of rotational movement.

alternative to metal ceramic and metal resin restorations. In its green state it is easily milled and then sintered to clinically acceptable characteristics that mirror the strength of metal. From an optical standpoint, it does not have the dark grey or grey brown color of metal ceramics. This new generation of metal free Zirconia restorations has generated extensive interest and use in Europe.

Figure 9: Occlusal surface of the copy milled green Zirconia. The screw access holes are checked for clearance, screw seat configuration and screw seating.

Figure 10: Intaglio surface of the copy milled green Zirconia. The internal bridging support elements and the foot piece are left in place until the first sintering to insure absolute stability.

Figure 11: Prior to sintering, the tissue areas of the frame are infiltrated with pale pink tissue color and the teeth with tooth colored liquids. The frame has just been removed from the furnace. It illustrates the ideal light purple color attained after the first bake.

Zirconia is an excellent alternative for patients with metal allergy and sensitivity.[11] Currently, there are very few laboratories in the United States that have the capability to produce these restorations.

CLINICAL EXAMPLE

A 59 year old male patient of record presented with a maxillary implant supported porcelain fused to metal restoration dating back to the 1990's that was failing (Fig. 1). The original treatment involved bilateral sinus augmentations, the placement of ten Frialit-2 implants (Dentsply-Frialit, Mannheim Ger.) and a three segment, precision attachment interconnected PFM full arch restoration. In 2009 the T block joint between the right cuspid and first bicuspid failed and the right posterior and anterior segment was mobile. Several efforts to remove the fractured retaining screw and to re-tap the T block screw recess proved unsuccessful. For an extended period of time the patient was unable to pursue additional treatment due to significant systemic issues. By the time active treatment was resumed, considerable bone loss had occurred around numerous implants in the right quadrant. The failing

Figure 12a: Illustrates the excellent passive fit that is obtained with the sintered Zirconia frame. Regardless of it size, there is not distortion during repeated firing for porcelain and stain application with Zirconia.

Figure 12b: Illustrates the excellent passive fit that is obtained with the sintered Zirconia frame. Regardless of it size, there is not distortion during repeated firing for porcelain and stain application with Zirconia.

Figure 13: A variety of porcelains and stains can be applied with repeated firings to obtain an ideal soft tissues color specific to the patient.

and compromised implants were removed and the sites grafted. Six months later, six Nobel-Biocare implants (NobelBiocare, Yorba Linda, CA) were placed in sites 2, 3, 5, 8, 9 and 11 (Fig. 2). An immediate loaded provisional fixed restoration was inserted at the time of the surgery. In planning the definitive restoration, the decision was made to fabricate a one piece Zirconia fixed complete denture.

CREATING THE PROSTHESIS

Variations of the Zirconia fixed complete denture have been previously described.[12] The first step in the process was to generate a full contour wax up to visualize the end result (Fig. 3). The set up was then duplicated and poured with PolyDie epoxy resin (Vident-Vita, Brea, CA). The individual epoxy teeth were sectioned from the model and trimmed. On the mounted master cast, metal cast to cylinders were attached to the abutment analogs. The cylinders were adjusted to the correct vertical and the individual custom epoxy teeth were set with wax onto the master model. Adequate space was left between the epoxy teeth and the tissue level on the model to accommodate the profile prosthesis flange (Fig. 4). The master model with the completed wax up was then

Figure 14a: Veneers and crowns pressed in Authentic porcelain are in place on the Zirconia frame. Facial and occlusal aspects of the completed restoration with veneers in place confirm the natural appearance and excellent esthetics obtainable with this technique.

Figure 14b: Veneers and crowns pressed in Authentic porcelain are in place on the Zirconia frame. Facial and occlusal aspects of the completed restoration with veneers in place confirm the natural appearance and excellent esthetics obtainable with this technique.

Figure 15: Screw access holes exited on the facial of 11 and 12. The cemented veneers completely mask and hide those entries. In the event of possible future breakage, duplicate veneers can be made in advance to facilitate repairs without removing the entire unit.

duplicated with silicone and poured with PolyDie. The resultant model has the same precise anatomy and locations of the implant mating surface (Figs. 5A, 5B). The PolyDie model is then refined, the screw access holes uncovered and any bubbles or defects repaired. The model is returned to the clinician for try-in at which time the basic esthetics and occlusion aspects are verified and corrected.

Once returned to the laboratory, the model is modified with preparations to receive veneer or crowns in the anterior segment (Fig. 6). The model (frame work) is then traced on a polyurethane disc (Figs. 7A, 7B). The disc is cut out and the frame is bonded to the support elements of the disc. The disc is then secured in one of the mounting rings of the Zirkograph (Zircon-Zahn, Bruneck, IT) along with a mirror image green Zirconia block in the adjacent mounting ring (Fig.8). When both units are secure, the details

Figure 16a: The completed fixed Zirconia denture bridge in place. Space is provided between the prosthesis and the mucosa for adequate hygiene access both facially and lingually.

Figure 16b: Post insertion smile.

of the master model are manually copy milled into the block of green Zirconia in the replicating frame with a variety of cutting instruments (Fig. 9). Rotating the disc 180 degrees allows the intaglio surface and the details of the abutment/prosthesis interface to be replicated (Fig. 10). The Green Zirconia frame can be further refined with a dental handpiece if necessary. The frame is then painted with base colors and fired in a vacuum furnace. The heating and cooling cycles of the frame are rigidly controlled for optimal physical properties. Fresh out of the oven, the ideal light purple color of the frame becomes evident (Fig. 11). The frame work is then tested on the master model for a perfect passive fit (Figs. 12A, 12B). Once the Zirconia has been sintered, repeated firings will not alter its dimensional stability. A variety of colors are readily available to achieve an esthetic result (Fig. 13). Typically, multiple additional layers of colors and stains are necessary to obtain the depth and vibrancy necessary to replicate living tissue and natural shades. Once the frame was completed, the anterior veneers and crowns were pressed in Authentic porcelain (Jensen Dental, North Haven CT) and fitted onto the Zirconia frame work (Figs. 14A, 14B). Because of the facial angulation of implants 11 and 12, the screw access holes exited on the facial aspect of the clinical crown (Fig. 15). Cementing porcelain veneers over the preparations after the frame was inserted in the mouth resulted in optimal esthetics of the anterior segment and the complete masking of the anterior screw access holes (Fig. 16). On seating, the occlusal parameters were again checked carefully and the patient was given thorough oral hygiene instructions. Typical regiment includes the use of an oral irrigation devise with an antimicrobial rinse, an end tufted brush and Superfloss.

SUMMARY

The all Zirconia restoration offers a very strong and esthetic metal free option for those patients who desire that option. Although there is limited documentation in the literature, this technique and material has been used very successfully in Europe since its introduction in 2005. It can be used for fixed bridgework applications as well as any application where there is a deficiency of soft tissue. If it can be created in wax or resin, it can be replicated in Zirconia. What distinguishes this technique is the simplicity of direct copy milling with the Zirkograph. Zirkon Zahn's Prettau Zirconia is also unique in that the Zirconia itself is more translucent allowing the creation of a more natural appearing restoration.

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

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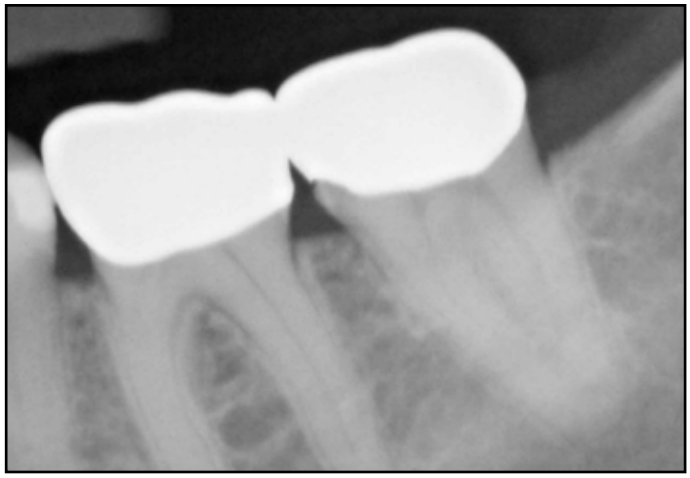
Gingival Grafting: A Novel Approach to Single Stage Augmentation for Root Coverage

Dr. Preety Desai, BSc, DDS[1]

Abstract



The existence and preservation of attached keratinized gingiva around natural teeth and dental implants plays an important role in periodontal and peri-implant health. This paper describes a novel surgical technique that addresses multiple adjacent Miller class II and III recession defects in a predictable one staged surgical procedure. The goal of treatment is to improve esthetic outcomes, gain clinical attachment and keratinized tissue levels in addition to possible root coverage. A combination of traditional periodontal plastic procedures is utilized with sound evidence based techniques. To date, over 100 surgical cases have been completed. Surgical steps and rationale for this new technique are detailed and representative cases will be shown.

KEY WORDS: Gingival grafting, keratinized tissue, Periodontics, root coverage, recession

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INTRODUCTION

As many epidemiological reports suggest, gingival recession affects the majority of the adult population.[1-3] Gingival recession is defined as the apical migration of the soft tissue margin around teeth leading to exposure of the cementoenamel junction (CEJ) and the dentinal root surface[4] and is classically categorized by Miller.[5,6] The philosophy for increasing the zone of keratinized tissue for teeth is for attachment stability, facilitation of plaque control and to prevent further gingival recession from frenal/muscle pulls.[6,7] Periodontal plastic procedure articles in the literature evidentially demonstrate very predictable and esthetic root coverage in the majority of Miller class I & II single or adjacent tooth sites with and without the adjunct of a subcutaneous connective tissue graft (SCTG)[3,7] irrespective of the surgical technique/s utilized (ie pedicles, tunnels, coronally positioned flaps (CPF), guided tissue regeneration (GTR) etc); provided that biologic principles for obtaining root coverage are satisfied (ie interproximal papillary height and interseptal bone height). In addition, the results of long term clinical retrospective studies in private practice demonstrate that not only is there effective root coverage but indeed mean root coverage tends to improve over time after initial surgery.[8] In acellular dermal matrix and GTR studies over the short and long term, neither showed a statistically significant increase in root coverage as opposed to the use of autogenous tissues.[9,10] The literature also shows clinical cases of inexplicable root resorption in SCTG cases performed in a traditional manner more recently.[47,48] In contrast, the presence of multiple recessed sites in a posterior sextant which have advanced recession beyond Miller class I/II presents a clinical conundrum which, in the literature and clinical periodontal practice of periodontics, has not been addressed until just recently.[3,11,12] Nevertheless the goal of periodontal therapy should be to address the needs and wishes of each patient, and treatment options should be made available to them.[13]

Recession in multiple adjacent teeth can occur for a variety of reasons: the patient's iatrogenic habits, history and/or treatment of chronic periodontal disease by traditional flap therapy, anatomy/malpositioned teeth in the alveolar ridge corridor compromising attachment apparatus, muscle/frenal attachment levels at or beyond the mucogingival junction (MGJ) and secondary parafunctional habits in addition to the obvious long standing results of a history of chronic untreated periodontal disease.

A two staged surgical a) free gingival graft (FGG) + b) surgical repositioning coronally positioned flap (CPF)[12,14] procedure can aid individual sites in some Miller II, III recessed areas. These surgical sites which have experienced two surgeries are prone to double the postoperative surgical shrinkage, fibrotic scar tissues and morbidity.[30] Patients also report discontent with this treatment option as a result of the need for two surgeries due to increased costs, healing time, work absences and scheduling issues. In difficult economic times, the dental profession must streamline treatment options for patients but still continue to deliver excellent surgical skills to our patients along with the subsequent clinical benefit.

In posterior sextants where there are multiple recessed Miller class II/III sites accompanied by a lack of adequate keratinized and attached gingiva where the adjacent papillae may or may not be affected: treatment options are currently limited. As such, an effort has been made to fill this void

Figure 1: Case I lower left sextant presurgical photo.

Figure 3: Case I lower left postop clinical follow up.

with a corrective surgical procedure able to stabilize progressive recession with the added benefit of some root coverage in Miller III recessions.[11]

INCLUSION CRITERIA FOR SINGLE STAGE CPF/FGG

Patients eligible for the one stage CPF/FGG procedure included those with: 1) no health issues as a contraindication for periodontal surgery 2) presence of at least two to three adjacent teeth with Miller II/III facial recession with a frenal attachments deemed to be playing a role in creating a stable gingival margin 3) chief complaint of impaired esthetics associated with the recession 4) absence of anatomical defects, caries or restorations needed in the site 5) no periodontal surgical treatment of the involved sites during the previous 24 months 6) adequate oral hygiene 7) non smokers.

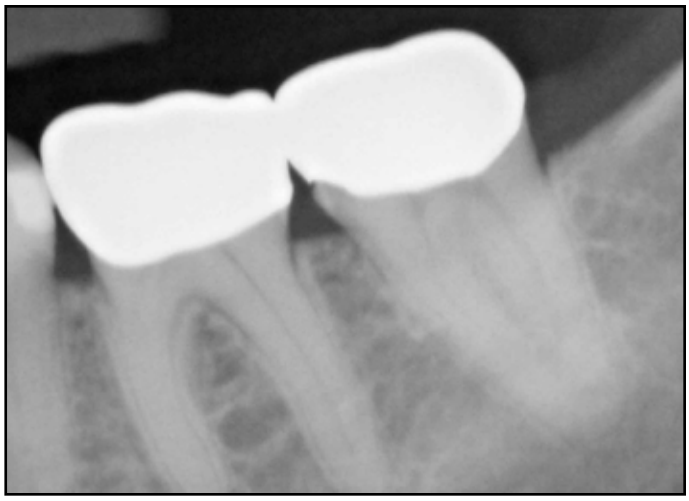

Figure 2: Case I lower left periapical xray.

PROCEDURE

Patients chosen exhibit posterior sextants of recession with interproximal bone loss (Miller II or III) and encroachment of gingival recession on the MGJ, commonly with frenal pulls and muscle attachments which may or may not have played a role in the etiology of attachment loss but will play a role on the success and stability of surgical treatment to resolve progressive recession.[15,49]

A modified one staged FGG + CPF[12,14] surgical approach is suggested: implementing Sumner's full thickness envelope[16] and Sorrentino and Tarnow's[17] semilunar procedure augmented with

Figure 4: Case II upper right presurgical photo.

Figure 5: Case II upper right surgical flap photo.

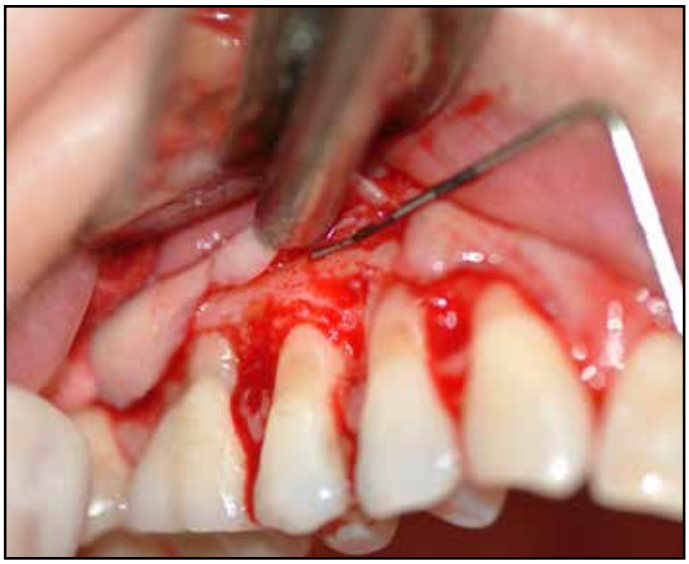

Figure 6: Case II upper right surgical flap repositioned photo.

Figure 7: Case II upper right postop photo 1.

a traditional FGG[18] apical to the coronally positioned semilunar flap is suggested. This combination procedure proposes to inhibit the coronal reattachment of the musculature and freni which can play havoc with graft stability in the long term,[49] in addition to increasing the zone of keratinized and attached tissues. Results showed that most class III recessed cases even showed some root coverage in addition to an ample gain in keratinized(KT) and attached tissues (AT).[11,12]

The first incision was performed by the Er,Cr:YSGG laser (with appropriate soft tissue settings due to its known properties of hemostasis). The T4 laser tip incises precisely at the MGJ in a contact/non-contact manner depending on the extent of fibrous and ligamentous fre-

Figure 8: Case III upper left pre surgical photo.

Figure 9: Case III upper left post surgical photo.

nal attachment to make a split thickness incision release of all musculature/fibers prior to reaching the periosteum. All elastomeric fibers are thus incised and denatured at the MGJ. This allows the mucosa to apically relax, laying passively extending the vestibular region without causing any tension on the future graft's recipient surgical site. Rarely was vestibular suturing needed for hemostasis in the region unlike with a traditional blade incision. Resorbable 4-0 gut sutures are used in the vestibule for this purpose.

Root preparation is done in a conservative manner if the anatomy is deemed to be inhibitory to coronal flap positioning and stability (ie. in root abrasion, horizontal grooving, caries cases, etc). The root surfaces are traditionally modified with root planing to remove calculus, plaque, debris and to create a flat/convex architecture and etched with the hard tissue setting with the Er,Cr:YSGG at the coronal gingival margins prior to suturing of the coronal flap.

The second incision is the release of the coronally attached keratinized tissues incised as an envelope flap[19] from the sulcus in a full thickness manner[20] with microsurgical blades, without the use of vertical incisions on the facial aspect and split thickness in the papillary regions. The flap is coronally positioned with vertical mattress interrupted sutures using 6-0 non resorbable monofilament microsurgical sutures. Once the coronally placed flap is secure, then the soft tissue laser setting of the Er,Cr:YSGG allows gingivoplasty/gingivectomy by microplasty of the marginal tissue outline and adaptation of the marginal papillary regions of the gingival margins. An ideal scalloping in the manner of a "paintbrush" stroke of the laser tip allows the coronal architecture of the free gingival margin (FGM) adjacent to the teeth to adapt the marginal tissues precisely. This gingivoplasty allows the whole site to have a more finessed marginal gingival adaptation and contoured appearance against the dentition. The whole coronally positioned tissue is still attached with its mesial and distal blood supplies intact and is now fixed with interproximal sutures gaining blood supply from the split thickness papillae and the alveolar bone beneath it. The coronally positioned tissue is immobile and well adapted

Figure 10: Case IV upper left presurgical photo 1.

Figure 11: Case IV upper left presurgical photo 2.

Figure 12: Case IV upper left post surgical photo.

interproximally to have the best chance of blood vessel anastomoses, but at the apical aspect it lays passively on the periosteal bed.

The donor FGG is then placed apical to the coronally positioned flap onto the periosteum and alveolar bone which has been cleared of any elastomeric fibers and sutured with resorbable interrupted 6-0 sutures engaging the periosteum and the apical aspect of the CPF binding the coronal aspect of the donor FGG down to create immobility and no dead space to ensure the best blood supply. The Er:YSGG laser is used at appropriate settings to actually "weld" and plasty the donor FGG with paintbrush strokes to the CPF at the junction of the new augmented KT/AT to create a more esthetic result and strengthen tissue junction. Pressure on the whole surgical site aids in hemostasis and immobility if needed prior to pack placement, avoiding any dead space or blood clots which may hinder a healthy blood supply for vascularity of the newly placed graft & tissue. Surgical glue is used if necessary for additional stabilization being careful to avoid any subtissue leakage which will impede healing. Thus the whole site is tension free with an increased vestibular depth and an increased zone of AT/KT without frenal/muscle hindrance in addition to the potential of root coverage.

Traditional postoperative instructions, analgesics/anti-inflammatories are prescribed and patients are followed at 1(pack removal), 3(suture removal) and 6 week intervals for

Figure 13: Case V upper right presurgical photo.

Figure 14: Case V upper right postsurgical photo.

follow-up as with traditional periodontal plastic procedures. Patients were asked to refrain from any mechanical hygiene techniques in the treated area for the 3 weeks following surgery and were prescribed 0.12% chlorhexidine mouthwash to be used 3-4 times per day during the 3 weeks after the procedure.

RESULTS

All patients demonstrated surgical results that had an improved and stable zone of attached and keratinized tissues with no evidence of muscle or frenal reattachment compromising the zone of KT. Most often there was evidence of partial root coverage in class III Miller recessions. The typical white "scar" line evidenced at the MGJ discussed in Sorrentino & Tarnow's[17] original paper can rarely be seen in this one staged procedure. Patients also found the procedure no more arduous than any other periodontal plastic procedure and more often than not, the treatment was more comfortable than expected using the Er,Cr:YSGG laser for the initial incision. The author has done this procedure in over 100 cases with no untoward results and with great patient satisfaction.

DISCUSSION

In recession studies available to review, Miller I and II recessions are the majority found in the literature. In one such study[21] coronally advanced flaps were used for multiple teeth in the esthetic zone for root coverage and were noted to be stable after 1 year's time with a statistically significant increase in the amounts of KT. Yet in another study by Gurgan,[49] after 5 years 50% of these cases receded to the presurgical levels when alveolar connective tissue was used as donor as opposed to gingival tissue. Baldi[22] concluded that coronally advancing tissues in the treatment of multiple gingival recessions irrespective of the number of recessions or the minimal amount of keratinized tissue apical to the defects, is a successful method in which to achieve root coverage; but that a CPF thickness of >0.8mm was asso-

ciated with 100% root coverage and that there is a direct relationship between flap thickness and recession reduction. Animal & human papers demonstrate that altered gingival circulation and vitality as determined by fluorescein angiography show that more vascularity is associated with greater graft survival.[23] Hwang and Wang[24] also indicated that a positive association exists between weighted flap thicknesses and mean and complete root coverage.

Langer & Langer's[25] technique utilized partial thickness flap elevation to enhance revascularization of the graft, which was then stabilized on the recipient site using periosteal sutures. Raetszke[19] however advocated the use of the split thickness envelope in isolated areas only, reporting difficulty in obtaining sufficient tissue for use in more extensive areas of recession. However surgically, the elevation of a partial thickness flap can be arduous to perform, particularly in patients with a thin gingival biotype. A partial thickness flap also reduces the KT tissue thickness, and mucosal flaps less than 1 mm thick have been correlated with a reduction in the percentage of root coverage in defects treated using coronally advanced flaps.[22,27] Since bilaminar vascularity is required ONLY to provide blood supply to a SCTG, a full thickness CPF was used in this procedure.

Any chance of fenestration or dehiscence over the roots remaining after a full thickness CPF is compensated for by the FGG placed over these denuded sites and has proven to be historically not an issue[28,29] when grafts were placed straight onto the alveolar bone. No issues were observed due to coronally positioning a full thickness flap vs a partial thickness flap[26,29] and yet the benefit of maintaining the full buccal lingual thickness of KT remains a huge asset.[20] Also the elevation of a full or partial thickness flap did not appear to influence the amount of KT or the percentage of root coverage achieved postsurgically.[20]

Literature comparing the CPF vs semilunar flaps showed that both designs were effective in obtaining and maintaining a coronal displacement of the gingival margin. The CPF resulted in clinical improvements significantly better than semilunar flaps for percentage of root coverage, frequency of complete root coverage and gain in clinical attachment level.[27]

A recent review[50] points out that aberrant frenal pulls are a contraindication to the traditional CPF/SCTG as aberrant frenum cannot be corrected at the time of surgery because incisions would compromise the blood supply available to the graft. When indicated, a frenectomy is scheduled 4 to 6 weeks prior to grafting.[15,50] The beauty of the single stage laser CPF/FGG is that all aberrant frenal attachments are dealt with immediately in order not to compromise graft stability, or the microvasculature from the recipient bed and subsequent graft longevity and thus future recession of the new donor tissue.

In another paper, Harris[10] treated 266 defects with connective tissue grafts associated with a coronally advanced or a double papilla flap and reported that the average results of deep recessions ($\geq$ 5 mm) were less favorable (87% vs 95%), when connective tissue grafts were associated with a coronally advanced flap. Although these results were for Miller I and II recessions and showed better results than seen in the Miller III laser CPF/FGG procedure, they confirm limitations when recessions reach

5 mm.[30] In the traditional SCTG + CPF without vertical releasing incisions results in Miller III root coverage, ranged from 1 to 3 mm (mean 1.0 ± 1.5); and Miller IV recessions ranged from 2 to 10 mm (mean 1.86 ± 0.14) the number of Class III and IV recessions were fewer than class I and II recessions. Nevertheless the authors noted that these type III/IV clinical situations can be improved with this procedure.[12]

It has also been shown that when CPF plus CTG versus CPF procedures for root coverage are compared, the two surgical procedures resulted in similar degree of root coverage but the CPF's alone reverted to presurgical levels of the MGJ.[31] In addition, other long term papers evaluating CPF with CTG all show that an apical rebound of the MGJ occurs resulting in unstable root coverage and increased recession.[31,45,52] These findings may be explained by Ainamo et al.[51] who reported that the MGJ will regain its original apical position over time resulting in unstable root coverage while the current paper has reestablished a brand new MGJ by adding keratinized FGG apically.

A study comparing CPF techniques with and without the use of vertical releasing incisions both showed to be effective in reducing recession depth, but the envelope type of CAF was associated with an increased probability of achieving complete root coverage and with a better postoperative course. Keloid formation along the vertical releasing incisions was responsible for a poor esthetic outcome along with a longer healing period and a more uncomfortable postoperative course.[32]

Complete root coverage has been shown to be more likely in Miller I and II type recessions, when marginal tissue recessions are shallower: 66% for an average attachment level of 3.81 mm, in comparison to 50% and 33.3% for mean attachment levels of 5.23 and 5.5 mm, respectively.[33,34] Glise and Monnet-Corti also reported that percentage of root coverage was inversely proportional to the width and height of the initial recession dimensions.[35] Thus, even though the literature indicates that Miller III and IV recessions have little probability of 100% root coverage, increasing the KT and AT can increase the health and longevity of a patient's dentition.[54] Even if only some slight root coverage (based on individual anatomy and physiology) is possible, this may be a significant improvement for the patient esthetically, and also increases the chances of additional root coverage as a result of "creeping reattachment" for the patient.[36]

The Er,Cr:YSGG laser is used here for the first time in surgical grafting procedures as it allows a precision not possible with a surgical blade. Erbium lasers have the unique ability to vaporize water containing tissue because of its wavelength but also has a hemostatic effect to cauterize blood vessels without the requirement to pick up another laser machine at a different wavelength - translating to more practicality and efficiency in a private practice setting.

What is clearly observed is that the Er:YSGG laser allows the operator a "microsurgical approach" to finesse the marginal tissue adaptation at the coronal edges along with "laser welding" the FGG donor portion to the CPF portion of the surgical site and control the hemostasis without additional suturing. Pini Prato[37] showed that the gingival marginal position at the end of plastic surgery allowed for complete root coverage in Class I and Class II gingival recession defects, and apply-

ing this philosophy of treatment to the laser CPF/FGG will only enhance any probability of root coverage in Miller III/IV recession defects.

The elevation of a full thickness versus partial thickness flap does not appear to influence either the amount of keratinized tissue or the percentage of root coverage achieved post-surgically. In fact, the thicker coronal tissue, allows an increase in blood supply, surgical anchorage and less tissue trauma with better potential root coverage.[38] Pedicle and envelope flaps are successful if the grafted tissues remain vital on the exposed dental avascular root surface and soft tissue healing is critically controlled by this vascularity.[28,29] Most reaffirming was Romanos et al.[43] showing that the lateral bridging flap technique designed similar to this paper's CPF, exhibited the most stable location of the repositioned MGJ which was 2-3mm coronally over 5-8 years with stable root coverage and gingival margins.

Of further interest is that treatment success is more predictable with limited interproximal bone loss and undamaged interproximal soft tissue.[5,39] Gurgan commented that tooth location, vestibular depth, muscular and frenal insertions may affect wound stability once a flap is advanced.[50] Fombellida analyzed the significance of the "vascular supply" as a critical factor on the prediction of root coverage success; a positive balance between the vascularized and nonvascularized areas of the surgical field yields better results in terms of root coverage, even in those less favorable cases, such as Miller Class III recessions.[40]

A recent paper[53] presents a novel approach to root coverage with pinhole versus flap access and use of allograft donor tissue in anterior teeth only for Miller I, II and fewer III defects. The premise of this technique is for root coverage (40-80% after 5-33 months) while minimal KT (<1.5mm) was gained and in most cases lost (+/- 1.9mm). Only 2.8 teeth were treated per patient versus 4-5 in the current paper, nor was frenal relief discussed or mentioned for long term stability.

CONCLUSIONS

Clinicians have all too often are faced with the request "can you not do something to cover these teeth?" Many times the concern is not related to sensitivity but rather that of esthetics due to recession increasing over a period of time for a patient on a stable maintenance schedule. Once the periodontal health was assessed to be stable, the remaining compromised zone of KT/AT and the location of the muscle/frenal attachment often appeared to play a role in progressive recession. Thus the single staged laser CPF/FGG was developed and completed in over 100 patients and was reported to be a comfortable procedure with an esthetic improvement. There are even documented areas of root coverage in Miller III and IV situations and over the years some "creeping reattachment" has been documented.[36] More investigation in a prospective clinical study, with volumetric methodology[44] needs to be done in order to assess the statistical significance of increases in KT and root coverage results of this new procedure or with the adjunct of tissue engineering and biological adjuncts such as enamel matrix derivative, PRP (platelet rich plasma) or PRF (platelet rich fibrin).[41]

The CAF procedure is effective in the treatment of gingival recessions. However, recession relapse and reduction of KT occurred during follow up periods without any FGG adjunct.[42] The baseline width of KT is a pre-

dictive factor for recession reduction when using the CAF technique. Thus the new single staged laser CPF/FGG is an effective and predictable method to increase the zone of KT and AT width. The technique can also anecdotally be shown to increase root coverage in Miller III and IV cases and fulfills the need of the patient, while at the same time reducing the number of appointments and patient costs. ●

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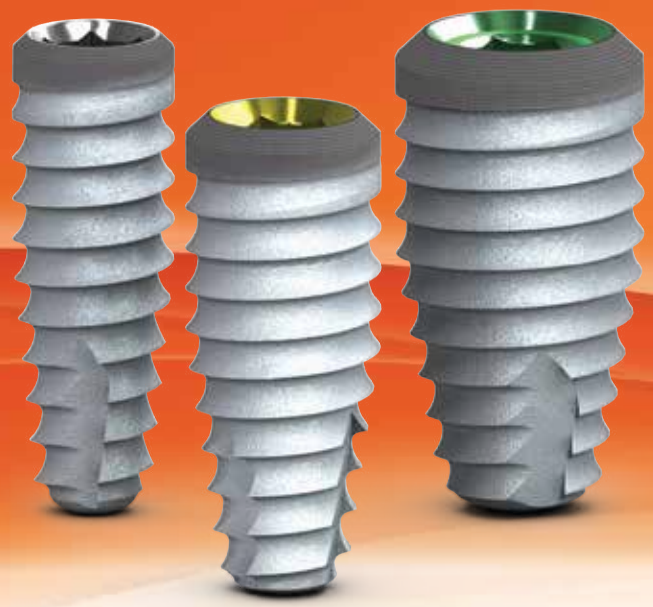

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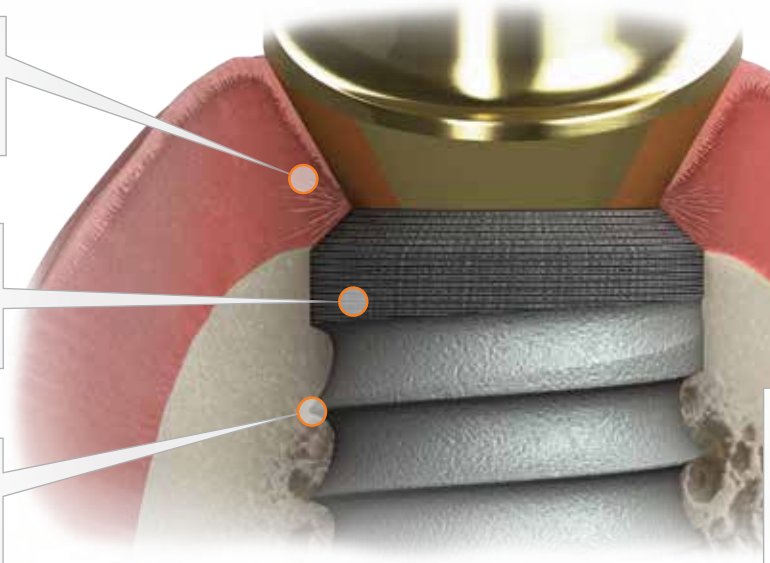

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Solving the Problem of Misangulated Implant Retained Overdenture with Bar Attachment: A Case Report

Dr. Ahmed Yaseen Alqutaibi [1] • Dr. Mohammed Farouk [2]

Abstract

Background: Mis-angulated implant is one of the main causes of frequent ball attachment maintenance, as a result of accelerated rate of plastic component wear.

Case Report: In this case report a treatment approach with bar retained implant mandibular overdenture were described to patient with history of frequent loss of retention of ball attachment retained mandibular implant overdenture the require new O-ring replacement of ball attachments every 6 weeks, the patient asked for solution for this problem as he cannot afford high coast of frequent maintenance.

Conclusion: The use of bar retained implant overdenture is vialed treatment option for mis-angulated dental implants.

KEY WORDS: Dental implants, bar attachment, implant supported overdenture, case report

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INTRODUCTION

The classical treatment plan for the edentulous patient is the conventional complete denture. However, this treatment has several complications that occur more frequently on the lower denture; this led the researchers to focus more on the mandibular jaw. Therefore, the problem of stability and retention of a complete denture is partially solved with the use of an implant retained denture, commonly known as an implant overdenture.

A wide variety of commercially available attachment systems are used to connect implants to overdentures either by splinting or un-splinting the implants, most commonly used include stud, bar, magmatic, and telescopic attachments.

One of the most encountered problems of ball attachment is the frequent need for maintenance, particularly O-ring replacement, this problem more frequently occur in case of mis-angulated implants placement. To decrease need for ball attachment maintenance the implants should be placed: Parallel to each other, equidistant from the midline, at the same level and perpendicular to the occlusal plane.

The bar and clip attachments are probably the most widely used attachments for implant-tissue supported overdentures as they offer greater mechanical stability and more wear resistance than solitary attachments. In addition short distal extensions from rigid bars can be achieved which contribute to the stabilization and prevent shifting of the denture.[1-3]

The assumed advantage of bar attachment is better transmission of forces between the implants due to the primary splinting effect, load sharing, better retention and the least post insertion maintenance.[4,5] This article addresses the problem of frequent of attachment retention loss of two implant mandibular overdenture retained by ball attachment; one of the placed implant was mis-angulated.

BACKGROUND

A 58-year-old, medically fit male patient presented to Prosthodontics Department, Faculty of Dentistry, Cairo University, with history of frequent loss of retention of ball attachment retained mandibular implant overdenture the require new O-ring replacement of ball attachments every 6 weeks , the patient asked for solution for this problem as he cannot afford high coast of frequent maintenance. Clinical and radiographic examination revealed two implant placed in the canines are with left one placed with distal angulation of about 20 degree (Figure 1).

TREATMENT

Pretreatment casts were made and mounted on an articulator; diagnostic setup was done and tried in patient mouth, this was performed to assess the inter-occlusal space, and it was found to be adequate and satisfactory. After discussion the problem with patient and getting his consent, the old ball attachment was removed and new bar attachment with new mandibular denture was constructed. Transmucosal abutment (OCTA abutment, DENTIS implant system, KOREA) was connected to implant fixtures and tightened properly by transmucosal abutment driver and torque wrench up to 35Ncm (Figure 2). Abutment level final impression, using open tray impression technique and Impression copings were used .a medium body Poly vinyl siloxane was injected was around impression copings and special tray simultaneously

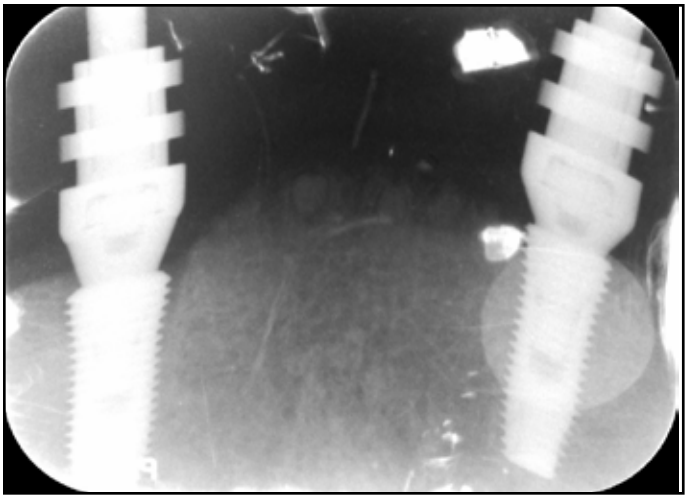

Figure 1: Intra-oral radiograph show distal tilting of left implant.

Figure 2: Transmucosal abutment connected to implant fixtures.

Figure 3: Abutment level final impression.

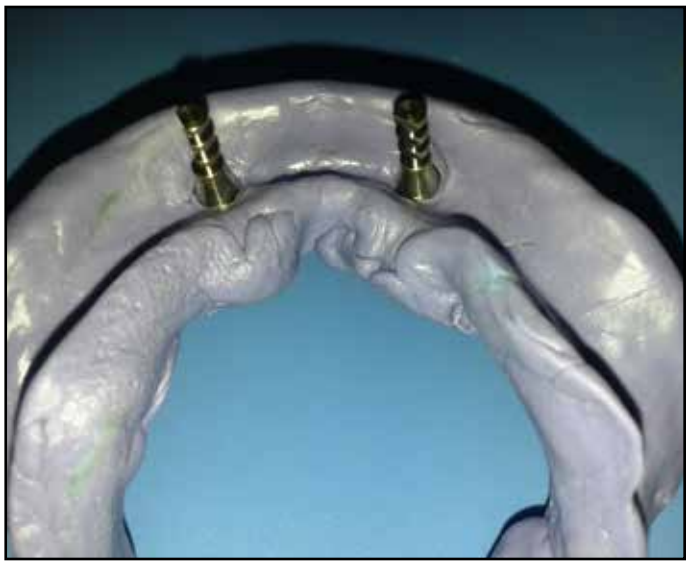

Figure 4: Abutment analogue was tightened to impression post.

(Figure 3). Abutment analogue was tightened to impression post ensuring immobility of the impression post during this process. Then a soft tissue mimic material was applied around gingival part of analogue and the whole impression was poured with improved stone (Figure 4). The verification jig was constricted and tried in patient mouth check for the passive fit (Figure 5). Castable abutment (plastic abutment, DENTIS implant system, KOREA) was used in this case over the transmucosal abutment. The dental surveyor and silicon index, made previously after try in of new complete denture, were used to ensure precise bar attachment plastic pattern placement

Figure 5: The verification jig tried in patient mouth check for the passive fit.

Figure 6: Silicon index used to ensure precise bar attachment plastic pattern placement.

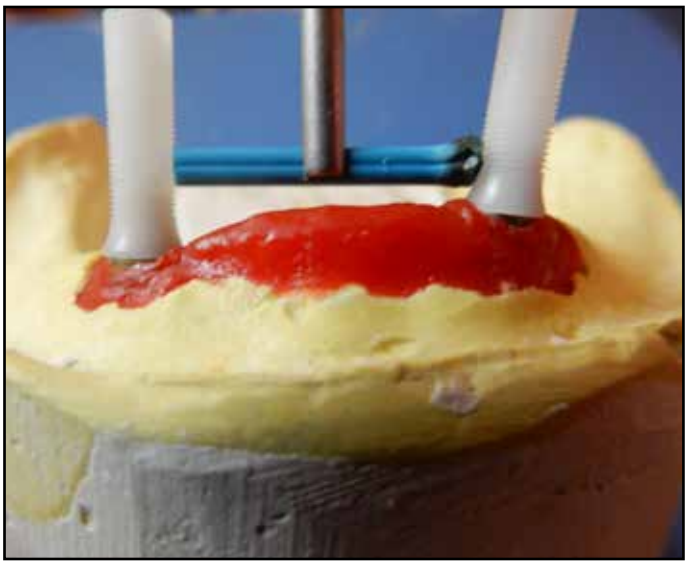

Figure 7: Surveyor used to ensure precise bar placement.

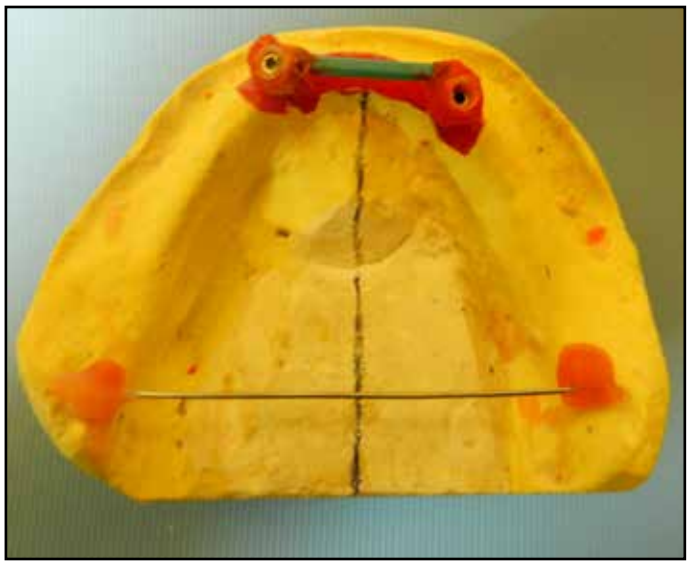

Figure 8: Final plastic pattern on the cast.

(Figures 6-8). The wax pattern was cast in a Ni-Cr alloy using standard technique. Casting was than retrieved, finished and highly polished to avoid any plaque accumulation along the bar**.** Then, the metal bars assembly was tried intra-orally to check for the passive fit. In this case the metal bar was cut and then re-soldered as result of misfit (Figure 9). After this step, the bar attachment assembly was connected to transmucosal abutment and tightened properly by screw driver and torque wrench up to 25Ncm. The remaining steps of the conventional denture construction were carried out as usual. The plastic clips were placed, the finished denture prepared for chairside pickup, using putty silicone to close the undercut

Figure 9: Metal bars assembly tried intra-orally.

Figure 10: Blockout under the bar with putty silicon.

Figure 11: Picked up retentive clips on the fitted surface of the denture.

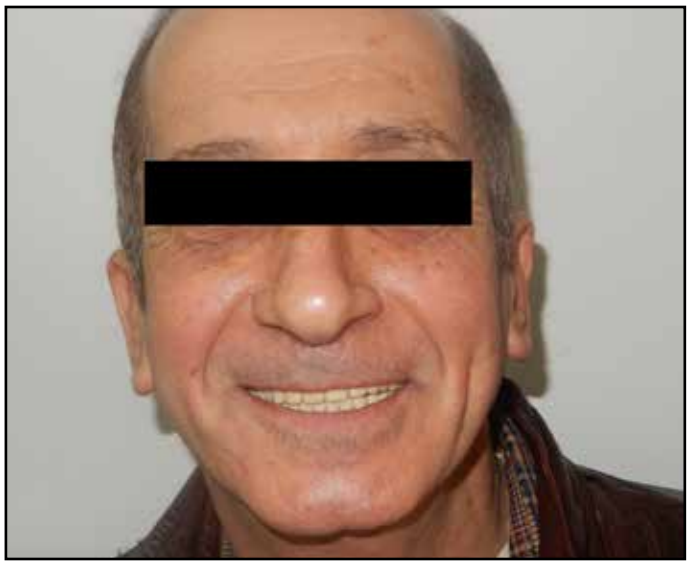

Figure 12: Patient happy with new prosthesis.

especially beneath the bar attachments, the prepared denture placed probably then the self-cured pickup acrylic resin was injected and the patient instructed to close in centric occlusion. The denture was retrieved from patient mouth, finished and polished (Figures 10,11).

DISCUSSION

The present case report describes the problem of frequent retention loss of ball retained implant mandibular overdenture, and solution of this problem by changes the ball attachments with bar attachment. A divergence of approximately 10 degrees between 2 non-splinted implants can

usually be tolerated; otherwise excessive wear of the attachment components may result from wider angles of divergence or convergence,[6] therefore, Implants should be placed as perpendicular to the occlusal plane as possible so that they are loaded axially without producing a bending moment.[7] It has been also suggested that angled implants was associated with more prosthetic repairs if inclined by more than 6 degrees[8]. In an attempt to correct these misalignments, bar attachments were used to splint these implants. It was even claimed that bar attachments placed on distally inclined implants offered better mechanical advantages than those placed on vertical implants with distal cantilevers.[9] The patient instructed to devote more interest for cleaning around the bar attachment. Proper oral hygiene around the bar is more difficult than for individual attachments. After one year follow up, the patient was very satisfied with new overdenture, with no maintenance required during the first year.

CONCLUSION

The present case report describes the problem of frequent retention loss of ball retained implant mandibular overdenture, and solution of this problem by changes the ball attachments with bar attachment this approach solve the problem of mis-angulated implant.

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

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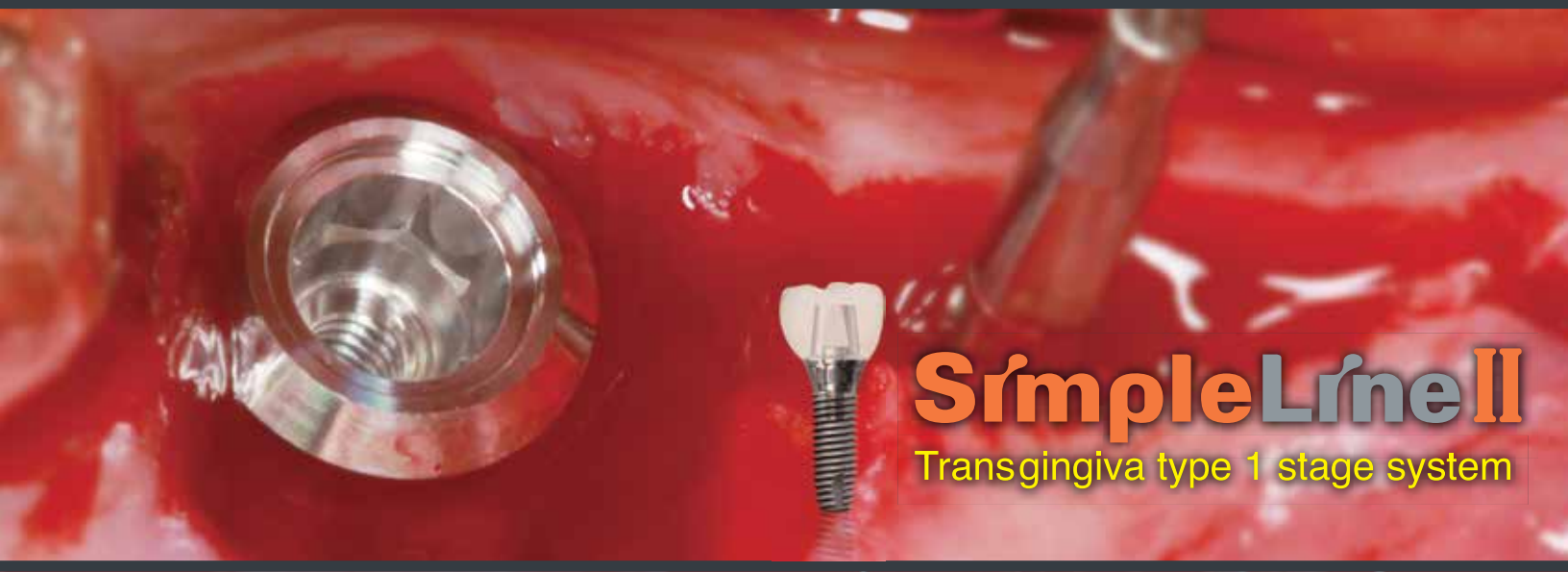

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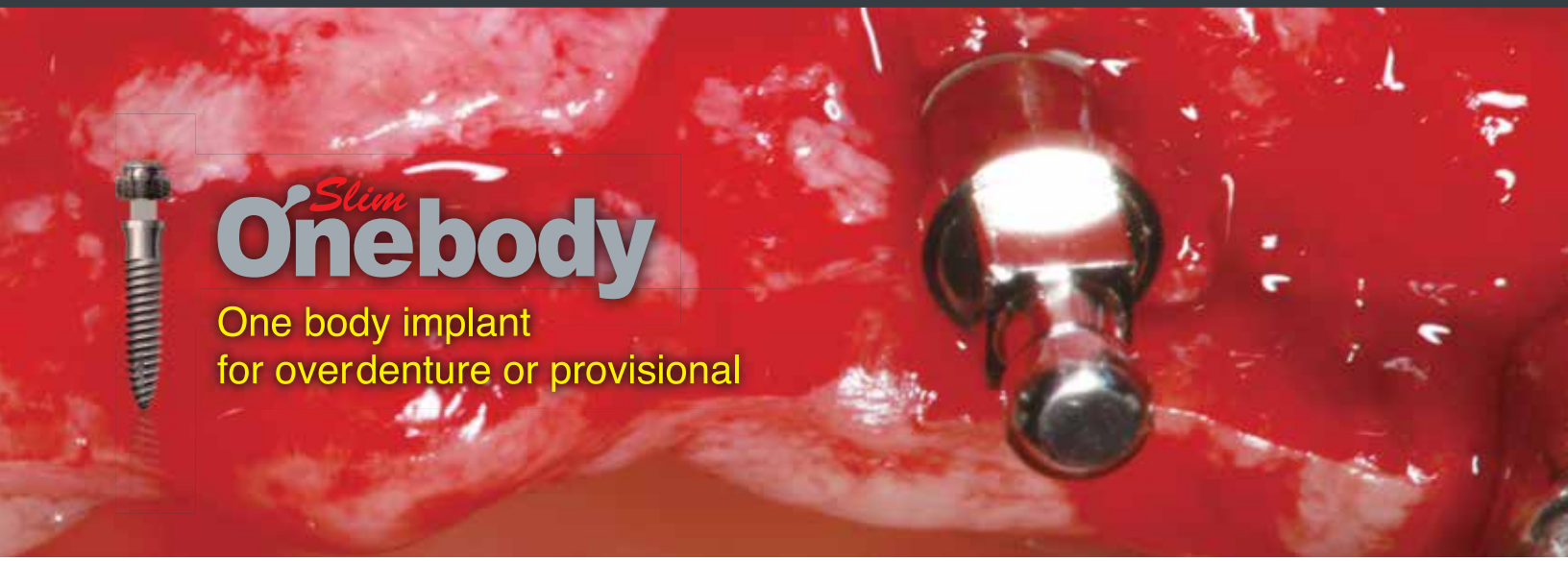
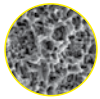
Transgingiva type 1 stage system



Slim Onebody

One body implant
for overdenture or provisional



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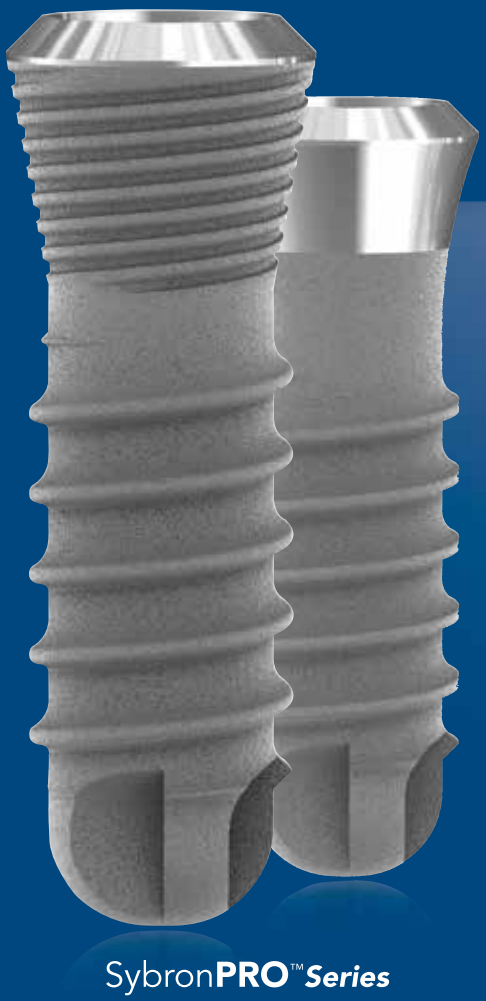

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[1] **Surgical and Mechanical Techniques to Increase Stability of Dental Implants**. Kharouf, Zeineb; Oh, Hyeong Cheol; Saito, Hanae; Cardaropoli, Giuseppe; Bral, Michael; Cho, Sang-Choon; Froum, Stuart; Tarnow, Dennis. Ashman Department of Periodontology and Implant Dentistry, New York University. Research presented at the AO Boston 2008.

[2] **Implant Design and its Effect on Preservation of Crestal Bone Levels**. Jang, Bong-Joon; Pena, Maria Luisa; Kim, Mean Ji; Eskow, Robert; Elian, Nicolas; Cho, Sang-Choon; Froum, Stuart; Tarnow, Dennis. Ashman Department of Periodontology and Implant Dentistry, New York University. Research presented at the AO Boston 2008.

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