The Use of Concentrated Growth Factors As Alternative To Bone Substitutes For Sinus Augmentation.

The placement of dental implants on edentulous posterior maxilla could present difficulties due to a deficient posterior alveolar ridge, unfavorable bone quality and increased pneumatization of the maxillary sinus.[1] An increased implant failure rates in the posterior maxilla related with insufficient residual height and poor bone quality.[2] Such problems have been overcome by increasing the alveolar height with maxillary sinus augmentation. Even sinus augmentation using subsequent graft material has become well-established treatment for decades, [3-5] some studies reported successful bone formation and osseointegration in cases of performing sinus membrane elevation without bone grafts.[6-7]

The aim of this case report is to evaluate the effect of concentrated growth factors grafted into the maxillary sinus without bone substitutes.

What are concentrated growth factors?

Growth factors are proteins which regulate in the complex processes of wound healing. Growth factors play a main role on cell migration, cell proliferation and angiogenesis in tissue regeneration phase.[8] These growth factors are mainly located in blood plasma and platelets. Platelet concentrate such as platelet rich plasma (PRP) have been used to accelerate tissue healing for a long time. But the effect of PRP is controversary regarding on hard tissue regeneration.[9] Unlike PRP, CGF is well known to accelerate new bone formation.[10] PRP uses complex protocols to prepare and chemical additives, concentrated growth factors (CGF) overcomes these disadvantages of PRP. The preparation of CGF is simple. Compared to PRF, CGF is attained by single centrifugation using special centrifuge. In addition CGF doesn't require any chemical or allergenic additives, such as bovine thrombin or anticoagulants, so is free from viral transmission disease. [11] CGF is 100% autologous fibrin.

PRF was introduced by Choukroun in the first time. The protocol of CGF is very simple. The venous blood sample is taken without anticoagulants in sterile 10mL tube and immediately centrifuged in special centrifuge device (Medifuge, Silfradent srl, Sofia, Italy) for 12 minutes. (Fig 1)

Figure 1. Special centrifuge for the preparation of CGF (Medifuge, Silfradent srl, S.Sofia, Italy), one step protocol is needed to obtained CGF from blood sample unlike PRP

Because anticoagulants are not used, the blood sample should be centrifuged immediately after taking blood sample to best quality of CGF. After centrifugation, CGF is obtained between acelullar plasma at the top layer and red corpuscles at the bottom layer. (Fig 2-3) Surgeons can use CGF as barrier membrane to accelerate soft tissue healing or be mixed with bone graft to accelerate new bone formation. In this report, CGF was used for sinus augmentation without bone substitutes in order to reduce healing time.[12]

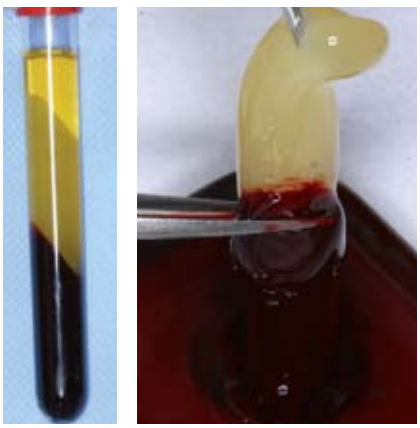

Figure 2 - 3. Concentrated growth factors are aggregated in the middle layer after 12 minutes special centrifugation. Red corpuscles is separated from fibrin clot with scissor before use

Case report 1.

A male patient, 58 aged, presented to our department to replace the missing teeth with dental implants. Prior to each patient's selection, patients' medical history was carefully evaluated. Preoperative examinations with panorama (Pointnix, Seoul, Korea) and computed topographic scans were performed to determine the available maxillary alveolar bone height and existing sinus pathology. The bone height of remaining alveolar ridge at # 17 and # 16 was 5 and 2mm high respectively.(Fig. 4-6) Patients received, as 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 seven days. Surgery was performed under local anesthesia through maxillary block anesthesia by using 2% lidocaine that includes 1:100,000 epinephrine on September 5, 2008. Flomoxef sodium (Flumarin®; Ildong pharmacentical Co. Korea, 500mg i.v.) was administered one hour before surgery. The piezoelectric saw with thin blade (S-Saw, Bukboo Dental Co., Daegu, Korea), connected to piezoelectric device (Surgybone®, Silfradent srl, Sofia, Italy), and was used with copious saline irrigation to create the lateral window of the maxillary sinus after the elevation of a mucoperiosteal flap. The anterior vertical osteotomy was made 2-3mm distal to the anterior vertical wall of the maxillary sinus and the distal osteotomy was made approximately 15mm away from the anterior vertical osteotomy. The height of the vertical osteotomy was approximately 10mm. The sinus membrane was carefully dissected from the sinus floor walls with a flat blunt-edged instrument. After elevation of the sinus membrane, concentrated growth factors alone were grafted into the new compartment of sinus cavity. (Fig 7) Two implants (Scewplant implant, ImplantDirect Co, USA) were placed at the same time. The detached bony lateral window was repositioned to prevent soft tissue ingrowths into the sinus cavity and to promote new bone formation from the lateral wall of maxillary sinus (Fig 8). Flaps were sutured using interrupted mattress PTFE sutures (Cytoplast®, Osteogenic Biomedical, Texas, and USA) to achieve passive primary closure. Preoperative prophylactic antibiotic therapy was continued postoperatively for 7 days and the sutures were removed 14 days following surgery. After sinus augmentation, postoperative panoramic radiographs and cone-beam CT scans were taken immediately after surgery. (Fig 9-10)

A healing period of 4 months was allowed for the osseointegration of implants and new bone formation in the sinus. CT scans were obtained to assess the new bone formation around the implants after the healing on January 1, 2009. (Fig 11-12) During uncovering procedure on January 6, 2009, a biopsy specimen was harvested with 3 mm wide trephine bur at the lateral sinus wall. Periotest value was checked at

Figure 4. Panoramic view showing multiple missing teeth and hopeless teeth.

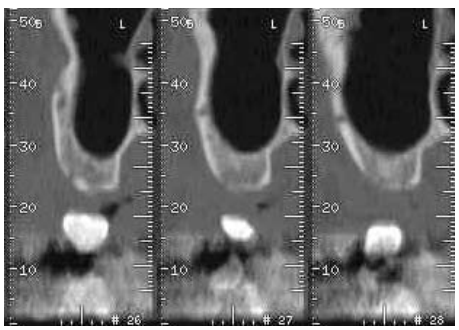

Figure 5. Cross-sectional view of CT scan showing 5mm high at # 17.

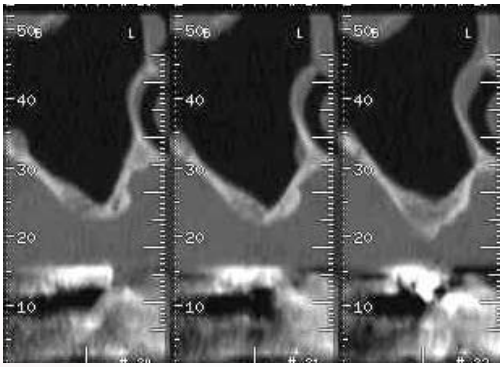

Figure 6. Cross-sectional view of CT scan showing 2mm high at # 16.

Figure 7. CGF alone was grafted into the sinus cavity.

Figure 8. Implants were placed simultaneously and the bony window was repositioned.

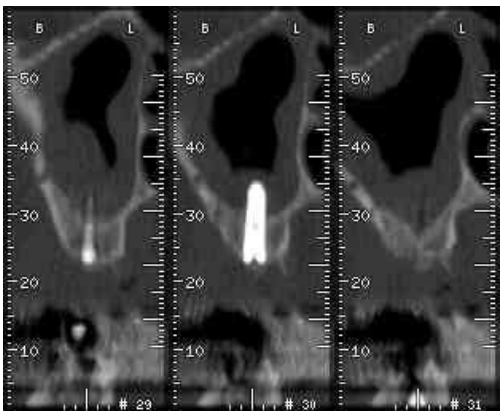

Figure 9. Cross-sectional view of CT scan at # 17 showing grafted CGF in the new compartment of maxillary sinus.

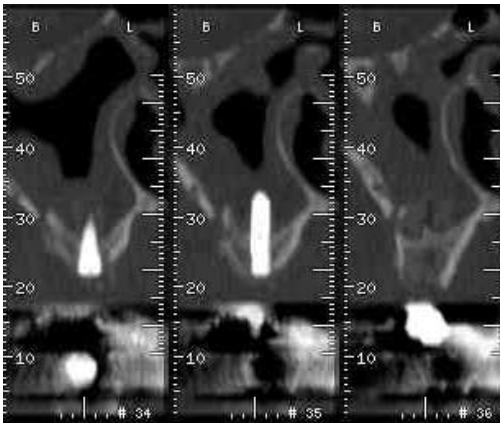

Figure 10. Cross-sectional view of CT scan at # 16 showing grafted CGF in the new compartment of maxillary sinus.

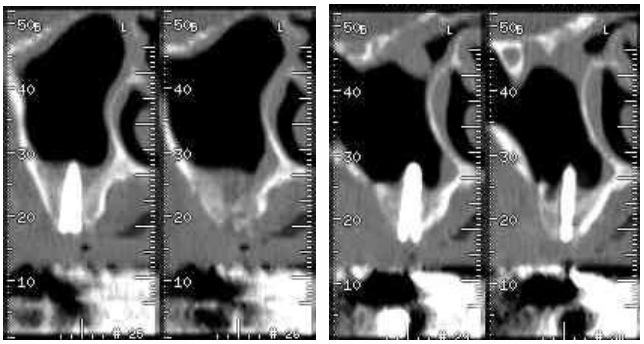

Figure 11-12. Showing new bone formation in the sinus at # 17 and # 16 respectively.

Figure 13. After 4 month healing, provisional prostheses was seated.

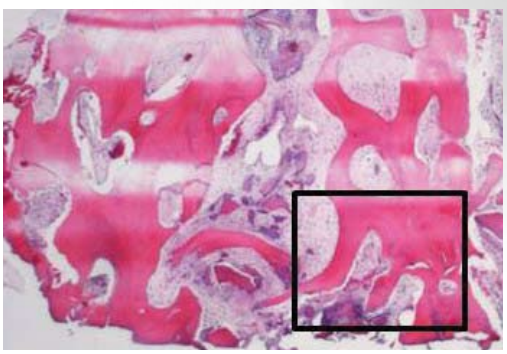

Figure 14. Showing active new bone formation (H-E stain, x12.5)

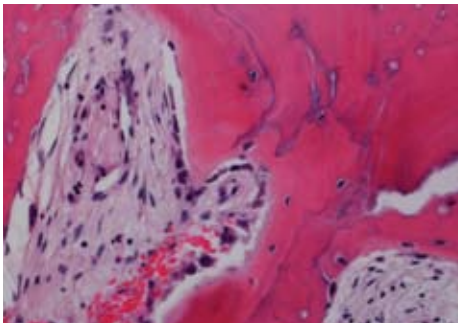

Figure 15. Showing active osteoblasts (arrow head, from black box of Fig. 14, H-E stain, x200)

the uncovering and showed -4 at # 17 and -3 at # 16, which means favorable osseointegration. Provisional prosthesis was seated on January 20, 2009. (Fig 13). The biopsy specimen showed active new bone formation without inflammation and abundant osteoblasts. (Fig 14-15)

Case report 2

A female patient, 50 aged, presented to our department to replace the missing teeth with dental implants. Same preoperative preparation as case report I was performed before sinus graft. The bone height of remaining alveolar ridge at # 17 and # 16 was 5 mm and 3mm high respectively. (Fig. 16) Sinus graft was performed on October 23, 2008. The piezoelectric saw with thin blade, connected to piezoelectric device, was used to make the lateral window of the maxillary sinus. (Fig 17) After detaching bony window, the sinus membrane was carefully dissected from the sinus floor walls with a flat blunt-edged instrument. Small sized membrane perforation was happened during membrane elevation and sealed with absorbable gelatin sponge (Cutanplast®). After elevation of the sinus membrane, two 4.1mm wide and 14mm high implants (Bestic implant, EBI Co, Daegu, Korea) were placed at the same time. Concentrated growth factors (CGF) alone were grafted into the new compartment of sinus cavity to induce new bone formation in the sinus. The detached bony lateral window was repositioned to prevent soft tissue ingrowths into the sinus cavity and to promote new bone formation from the lateral wall of maxillary sinus. (Fig 18-19) Guided bone regeneration was performed to regenerate new bone over the exposed implant surface. Flap was sutured using interrupted mattress PTFE sutures. Same postoperative management as case report I was performed. (Fig 20) A healing period of 3 months was allowed for the osseointegration of implants and new bone formation in the sinus. Plain radiogram and cone beam computed tomographic scans (Combi, PointNix, Seoul, Korea) were obtained to assess the new bone formation around the implants after the healing on January 8, 2009. (Fig 21-23) Compared to preoperative CT scan at # 17 and # 16, new bone formation in the sinus is evident with CGF graft alone and only 3 with healing. The provisional prosthesis was seated after only 3 months healing after sinus graft. (Fig 24)

Figure 16. The bone height of remaining alveolar ridge at # 17 and # 16 was 5 mm and 3mm high respectively.

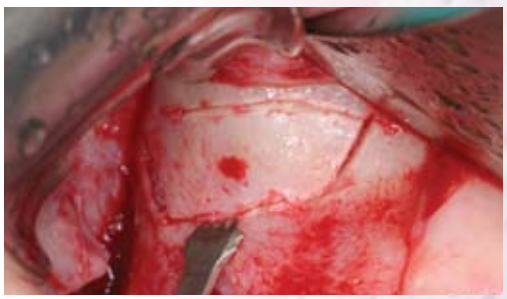

Figure 17. Surgybone and specially designed saw with thin blade was used to create bony window.

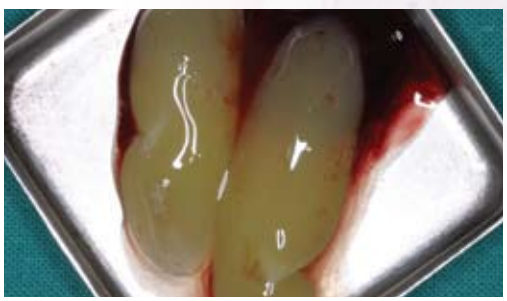

Figure 18. Collected concentrated growth factors.

Figure 19. Membrane perforation was developed during membrane elevation and repaired with absorbable gelatin sponge. Two RBM surfaced Bestic implants were placed simultaneously. The bony window was repositioned to prevent the ingrowths of soft tissue into the sinus cavity.

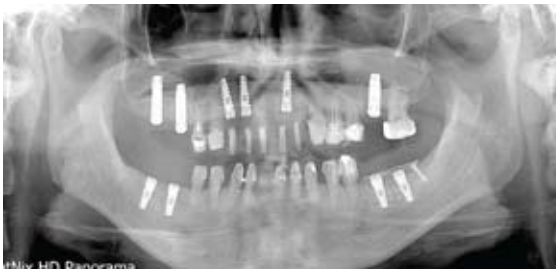

Figure 20. Postoperative panoramic view showing right sinus cavity filled with CGF.

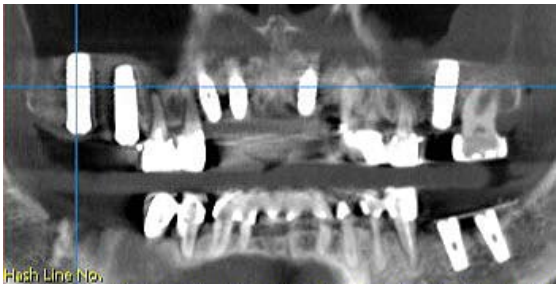

Figure 21. Panoramic image of cone beam CT scan after 3 months healing showed evident new bone formation.

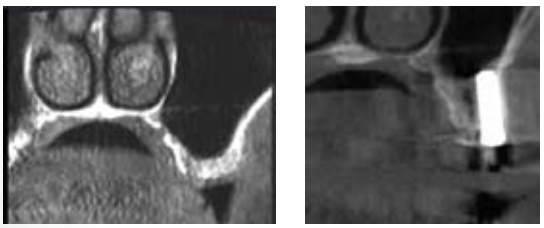

Figure 22 A and B. Comparison of CT scan between A (before) and B (after 3 months healing) at the site of # 16. New bone formation is evident with the CGF graft alone.

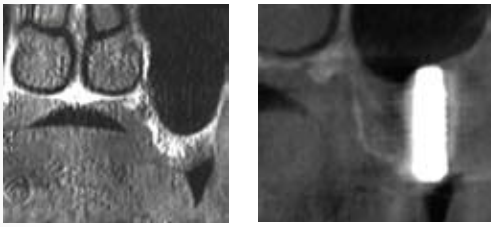

Figure 23 A and B. Comparison of CT scan between A (before) and B (after 3 months healing) at the site of # 17. New bone formation is evident too with the CGF graft alone.

Figure 24. Provisional prosthesis was seated after only 3 months healing.

Results and Discussion

The regardless of bone graft materials used, augmented maxillary sinus with variable bone grafts has been considered a prerequisite for the achievement of clinical success of implants placed into augmented maxillary sinus. However, successful new bone formation and osseointegration of implants were recently reported in the lateral approaches with performing sinus membrane elevation without bone grafts.[13-15]

Author's previous study on the new bone formation in the maxillary sinus with membrane elevation alone and simultaneous implant placement presented human histologic evidence for the first time.14 Also, according to a study submitted by the authors to journal of oral and maxillofacial surgery, the absorbable gelatin sponge loosely inserted under the elevated sinus membrane act as space maintainer for new bone formation in the maxillary as alternative to bone filler. All cases showed new bone formation in the new compartment of maxillary sinus without bone graft.[15] In addition, according to a study submitted by the authors to international journal of oral and maxillofacial implants, the injected venous blood taken from brachial vein under the elevated sinus membrane induced new bone formation in the new compartment of maxillary sinus.[16] So bone graft may not be a prerequisite for sinus augmentation according to our research. However average healing period until the uncovering was 7 months in author's study on sinus augmentation without bone graft. But in this case report, the healing period to be allowed new bone formation in the sinus was 3.5 months. CGF accelerates new bone formation and reduce healing time. To my knowledgement, this is the first report showing the success of sinus augmentation using CGF alone and fast healing capacity to make new bone formation in the sinus.

Precise osteotomy is essential to relocate bony window into lateral window.[17-19] This was possible by use of the piezoelectric saw with thin blade or reciprocating micro saw. The lateral bony window could be precisely repositioned because of the tilted osteotomy into the sinus, highly controlled and minimal bone loss during osteotomy. The precisely created bony window prevents the replaceable bony window to drop into maxillary sinus cavity. The application of conventional reciprocating saw in creating lateral bony window is irritating to patients because of the loud noise during surgery and risk of harming the soft tissue. As well, access to the oral cavity may be limited. Hence, the use of piezoelectric

device is recommended to create the lateral bony window to get direct visibility over whole osteotomies, highly precise bone cut by micrometric and linear vibration. [21, 33-35] The piezoelectric surgical device does not make soft tissue laceration or cause soft tissue burn during osteotomy In addition, piezoelectric device reduces membrane perforation during osteotomy in sinus bone graft or internal sinus elevation

Conclusion

Bone substitutes may not be prerequisites for sinus augmentation according to author's study. However similar healing period was needed for consolidation of new bone in the sinus. When applying CGF alone without bone substitutes for sinus augmentation, CGF may accelerate new bone formation in the sinus. In addition, CGF can be applied for guided bone regeneration, soft tissue healing, periodontal surgery and any other oral surgery associated with bony defects in order to reduce healing time and cost for bone materials and barrier membranes. Further evaluation on the effect of CGF is required.

In the next issue, internal sinus elevation using CGF alone will be discussed.

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