결손된 치조골 재건에 사용된 급속탈회 자가치아 블록 이식재의 임상 및 조직학적 고찰 : 증례보고

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Clinical, histologic evaluation of alveolar bone reconstruction using a rapidly demineralized autogenous teeth block graft in implant surgery : a case report

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Abstract

Successful replacement of the lost teeth and alveolar bone augmentation has the ability to maintain the ridge dimensions and allow the implant placement in an ideal position for the functional and aesthetic results. Tooth extraction inevitably has influence in bone resorption and changes in gingival contours. The aim of this study was to evaluate the efficacy of the rapidly processed autoteeth block(tooth osteoplant graft, TOP graft) as a biologic graft material for socket preservation. This is the simple method that makes reconstruction of alveolar bone of defect site after bone grafting by using newly novel graft material which is quickly processed tooth by using vacuum-ultrasonic system. This open up the possibility of extracted teeth recycle. This article reports on the success of using rapidly processed autoteeth block to treat 2 adult patients with periodontal problem as soon as extraction. The repairs were accomplished with socket preservation and with successful placement of endosseus implants.

Key words : rapidly processed autoteeth block, tooth osteoplant(TOP), socket preservation, vacuum-ultrasonic system

I. Introductions

In order to preserve and restore tooth which plays a key role in mastication, pronunciation and esthetics, alveolar bone with good quality is an essential requirement. Changes of alveolar bone ridge after a tooth extraction are inevitable. Several techniques and materials have been suggested for alveolar ridge preservation after dental extraction and before implant placement. Powder type of materials for guided bone regeneration(autogenous, allogenic, xenogenic and alloplastic biomaterials) maintain the volume of alveoli with the various membranes. Several graft materials have advantages and disadvantages respectivelyc. One of the effective graft materials that can meet this requirement and achieve reconstruction of the alveolar bone is indeed a tooth which is thrown away as surgical specimen. Tooth is composed of hydroxyapatite and type I collagen, and it is the most similar hard tissue to bone in body2. The fact that demineralized dentin can be used as graft material for regeneration of alveolar bone because it has bone forming ability was reported by Yeomans et al3, and it has been proven to be an excellent alveolar bone graft material in many animal examination and clinical studies targeting on humans later on4,5. Also, because it is processed the same shape of extraction socket, it provides an ideal condition for repair of alveolar bone that are essential to make easy manipulation during the operation.

In present, the focus of controversies over effectiveness of demineralized dentin as graft material is the long time it takes for decalcification and processing of tooth block as bone graft material. Decalicification process of tooth block takes longer than in bone3. Therefore, immediate grafting after extraction is impossible in the conventional processing method for socket preservation. In order that processing time has to be as shortened as to be used right after extraction has to be used to vacuum- ultrasonic system(VacuoasonicTM, Cosmobiomedicare CO., Seoul, Korea). Through vacuum ultrasonic technique, time for demineralization step which is a key of hard tissue graft material can be dramatically shortened to 2 hours.

In this study, we examined the clinical and histologic results of rapidly processed autologous teeth block graft at the time of implant placement.

II. Materials and methods

1) Principles of in-office, immediate and rapid processing tooth block graft.

A vacuum ultrasonic system which enables extracted tooth to be immediately and rapidly processed into graft material in-office. Ultrasonic creates a cavitation which has high energy inside in the course of repeating compression and expansion due to its characteristic of wave6. When this cavitation hits object' s surface, the energy inside is released and this released energy activates the reaction between reagent and the object. Also, effective formation and transfer of cavitation is affected by output of vibrator and ambient temperature. Because temperature affects preservation of protein substance of graft material, temperature also is one of the important factors of the processing device7. Because existence of dentinal tubules of tooth hinders quick demineralization by only ultrasonic, it is utilized periodic vacuum technology for preventing the air trapping.

2) Tooth block preparation

After extraction, remove remnant tissue around root by using surgical blade or periosteal elevator. In order to make removal of pulp tissue and perfusion of reagent effective, use dental handpiece to remove pulp tissue in pulp chamber and root canal. Also, make 0.3cm diameter holes as many as possible along the whole surface of tooth using 330 bur. Immerse the tooth in sterilization solution for 10 minutes in the vacuum ultrasonic system. For demineralization, teeth block were placed into a 0.6N solution of HCl for 90 minutes in the vacuum ultrasonic machine. Then they were washed for 10minutes in deionized sterile water or PBS solution using the machine in twice. Whole processing time took within two hours. After removing solution, the processed teeth graft materials are packaged into sterile tube.

III. Cases report

Case 1

A 72-year-old woman with periodontal and periapical lesion on #42-32 area presented for consultation

regarding implant treatment. The patient' s medical history was not significant for any medical conditions that would preclude bone grafting or implant treatment. Clinical examination showed a horizontal and vertical resorption on #42-32 area (Fig. 1a). The panoramic radiograph showed unadequate alveolar bone surrounding the incisors (Fig. 1b).

Fig. 1a. Pre-operative intraoral photo.

Fig. 1b. Pre-operative panorama.

The mandibular incisors on #42-32 had been extracted because of bone attachment loss and mobility. The decision was made to use the extracted anterior teeth for grafting. The extracted teeth were immediately removed soft tissue and pulp and fulfilled the holes (Fig. 2a, b). The demineralization process started in 0.6N HCl solution and thoroughly washed with the PBS in the vacuum-ultrasonic machine (Fig. 3).

Fig. 2a. Extracted mandibular incisors.

Fig. 2b. Preparation for the TOP processing.

Fig. 3. Processed teeth graft material(tooth osteoplant: TOP)

The processed tooth(#42, 32) materials were place into the extracted sites of #32, 42 for socket preservation, respectively. The decalcified teeth(#41, 31)were heaped up the residual anterior mandibular ridge as an onlay (Fig. 4).

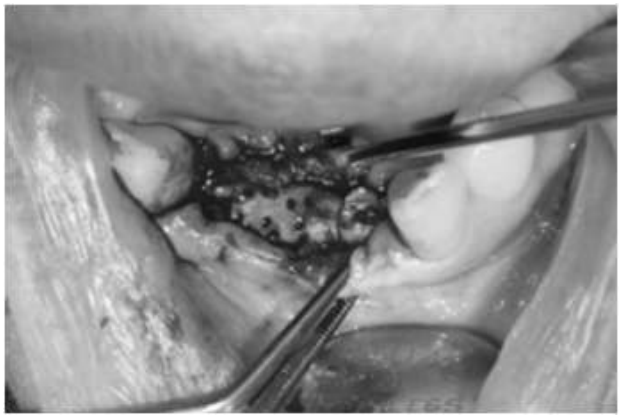


Fig. 4. Socket preservation on #12, 22 and onlay graft on #11, 21 extracted area with TOP block.

The oral mucosa layer was closed with No. 3-0 vicryl in a tension-free manner. Perioperative broad-spectrum antibiotics were used and continued for 1 week. The patient' s postoperative course was uneventful without any evidence of infection.

Re-entry at 3months showed good soft tissue healing and dense bone where the graft was placed (Fig. 5). Endosteal implants(TSIII, Osstem, Seoul, Korea) were placed in the socket preservation sites(#32, 42) (Fig.6). A 2mm core specimen of center of graft site was taken and sent for histologic evaluation (Fig. 7). The specimen showed large section of vital bone surrounding remaining particle of demineralized tooth material. The interface between new bone and processed autotooth graft was tight and interconnected (Fig. 8a,b,c). Implants were uncovered after 3months and noted to have good osseointergration with implants stability. 4-unit bridge was fabricated for the patient, achieving a satisfactory prosthetic result (Fig. 9). At 6months after final prosthesis, the patient' s periodontal health was good and a radiograph showed stable crestal bone position.

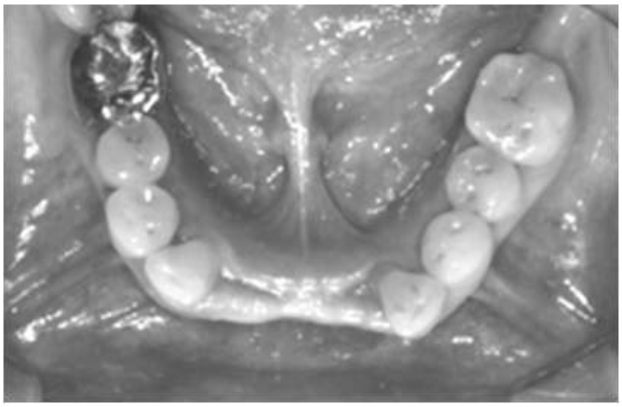


Fig. 5. Intraoral photo : post-operative 3months

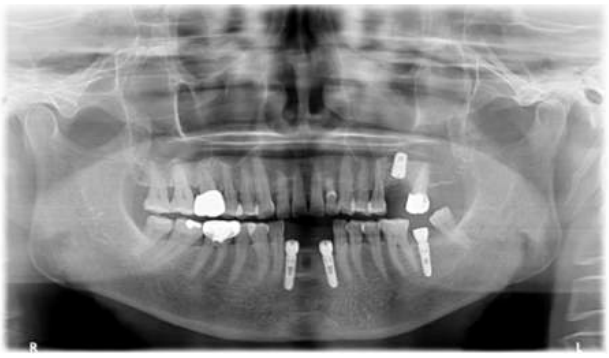


Fig. 6. Implant insertion on #12, 22 area after the 3months of TOP block graft.

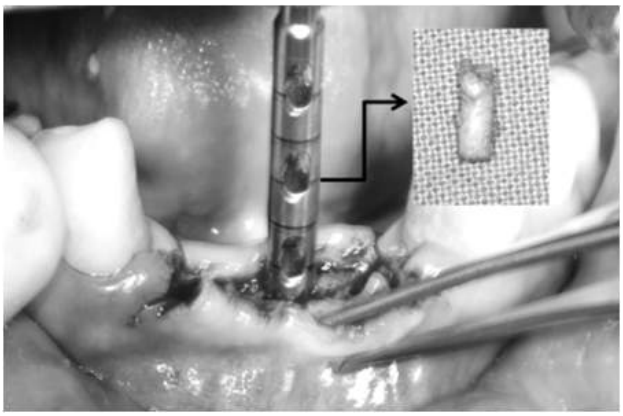
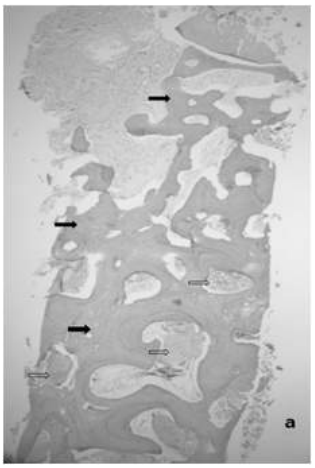


Fig. 7. Specimen site for histologic examination of TOP graft.



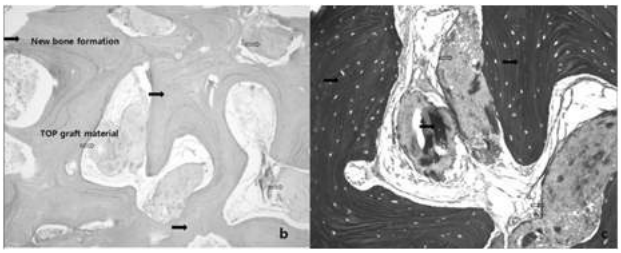


Fig. 8. Histologic findings : The interface between new bone and processed autotooth graft was tight and interconnected(black arrow : new bone, empty arrow : TOP graft). a. H&E X40. b. H&E X100, c. M&T X200.

Fig. 9. Prosthesis application.

Case 2

The patient was a 63-year-old woman with periodontal and periapical infections on #37. Clinical examination revealed the severe mobility of mandibular molor. Radiographic evaluation showed a radiolucent lesion (Fig. 10).

Fig. 10. Pre-operative panoramic view.

The alveolar ridge has undergone bone resorption buccally. The ridge presented with buccal dehiscence defect during placement of implant, which was augmented using autotooth grafting. The tooth was decalcified in 0.6N HCl, then washed before implantation. Demineralized autotooth block using the extracted #37 was used for socket preservation at #37 extracted area without trimming. After grafting, a titanium mesh was placed covering the graft site. The flap was closed over the graft and implant sutured using interrupted sutures. An immediate postoperative radiograph of the surgical site showed correct angulation and grafting support around the implant (Fig. 11). After a healing period of 6 months, second surgery was used to uncover the implant. The titanium mesh was removed and replace with a healing screw. A specimen was taken under the titanium mesh for histologic evaluation of grafting site. The section showed the vital bone surrounding remaining processed tooth material (Fig. 12). The abutment screw was threaded into position in the implant after healing of the gingiva and the final restoration was cemented to the abutment. 9 months postoperative radiograph showed maintenance of adequate bone level and density around the implant (Fig. 13).

Fig. 11. Immediate postoperative radiograph.

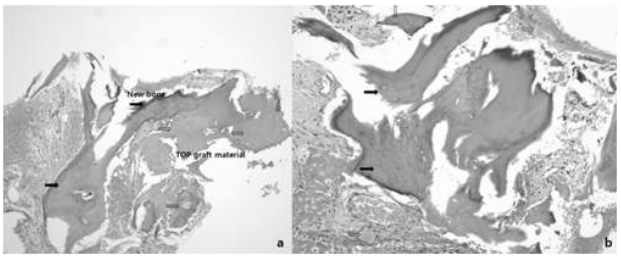


Fig. 12. Histologic findings : New bone formation around the TOP(black arrow : new bone, empty arrow : TOP graft). a. H&E X100. b. H&E X200.

Fig. 13. 9 months postoperative radiograph.

IV. Discussion

Alveolar ridge preservation following tooth extraction has the ability to maintain the ridge dimensions and allow the implant placement in an ideal position. Bone height and width always undergo dimensional changes after extraction of a tooth. The residual ridge forms a concavity without socket preservation. Bone does not regenerate above the horizontal level of alveolus crest, its height can not increase after the healing. The bigger labial or buccal wall defect due to trauma or disease, the bigger deformation of the contours1. Socket preservation helps to maintain the alveolar bone ridge and gingival anatomy for success of dental

implant placement. Several types of materials for the socket preservation and alveolar reconstruction are used. Current methods used to prevent ridge resorption include placement of particulate autograts, allografts, alloplasts, and xenografts. These biomaterials present advantages and disadvantages and, depending on their structure, shape and biochemical composition, may be resorbable or nonresorbable8. Choice of materials recommended in the literature depends on the planned time for augmentation. In case of short-term augmentation, autografts or allografts are used. The recent study states no advantage of fresh extraction socket augmentation with particulate autogenous bone chips9. The allograft is used rarely because of diseases transmission possibilities1. Materials for the average augmentation period are the xenograft. They can be observed the different resorption and bone formation according to the graft bone preparation temperature. These materials can be characterized having osteoconductive properties with long degradation period. For the 4 to 12 months augmentation period when patiens wish to postpone the implantation of later. Fillings for long-term augmentation with low resorption in the body are kept to be nonresorbable dense hydroxypatite. Synthetic graft material is what apatite which is a constituent of bone was processed in laboratory condition, and its effectiveness is either lower than that of xenograft or similar to it because complex structure like bone cannot be perfectly reproduced. However, immediate implant surgery after the extraction is on the rise, nowadays. The nonresorbable materials are not suitable for placement into sites that may later receive dental implants.

There is a group of materials marketed as being resorbable but more accurately may be considered as transitional bone grafting materials. They are especially useful as adjunts in guided tissue regeneration around implant site development. The most important feature of the materials is the ability to place endosseous implants into the grafted site8.

In other methods, immediate processed tooth graft materials are used for alveolar ridge preservation within 2hours after the extraction. Tooth is composed of hydroxyapatite and type I collagen, and it is the most similar hard tissue to bone in body. Also, because it has dense collagenous structure, it provides an ideal condition for cells such as mesenchymal stem cell or osteoblast that are essential to make new bone to differentiate and proliferate. In animal study, dentin matrix implants generated a significantly greater amount of mineralized tissue than did bone matrix implant10. Teeth are the hardest tissues in the body and have a highly mineralized extracellular matrix. Despite the effectiveness of demineralized dentin in bone formation, decalcification of tooth takes long time. Decalcification of dentin is more slowly than that of bone presumably because it is more dense and has neither old vascular channels or marrow space3.

For the decreased processing time, tooth has to be crashed into powder because permeation of reagent is not feasible. If it were to be used as block, demineralization method starting from outside to inside had to be proceeded for a long time in the conventional method. In this study, we tried the vacuum-ultrasonic accelerator for demineralized dentin in order to shorten the processing time. If ultrasonic washing effect and vacuum effect were combined like this, permeation of reagent into the inside even in dense structure like dentin could be possible, and clinical application could be more actively done because decalcification evenly occurs not only on outer surface but also inside of block form tooth. Total processing time of tooth block type is in only 2hours instead of the conventional 3-5days. The useful non-collagenous proteins in demineralized dentin are able to preserve by this new processing method. Pietrzak11 reported that measured levels of BMP7 would peak at the time(within 90 min) of maximal mineral removal, and then decline during continued long-term acid exposure due to extraction into the acid bath. This is simple surgical technique without shaping because those shape of extracted tooth remains the same after the process (Fig. 3). It is similar the re-plantation without crown portion. Not only this method has achieved faster demineralization time compared to the traditional method, but also it was observed good new bone formation in these clinical cases.

In our first patient, the large amount new bone formation was present on the whole. This bone was characterized by a dense appearance (Fig. 8a). Degradation of the deminealized dentin matrix was observed among the woven-lamella bone (Fig. 8b). We set out to optimize the demineralization method using the vacuum-ultrasonic system order to make it shorter for the preservation of the alveolar portion.

Ⅴ. Conclusions

Preservation of tooth alveoli using immediately processed extracted tooth after tooth removal is effective and
convenient practice. With the introduction of rapidly processed block tooth osteoplant technique, results are enhanced by good bone formation and successful implant surgery. Further studies are need to evaluation the long-term effects of demineralized dentin with vacuum ultrasonic accelerator and to develop standardized protocols for their use.

References

1. Kubilius M, Kubilius R, Gleiznys A. The preservation of alveolar bone ridge during tooth extraction. Stomatologija, Baltic Dental and Maxillofacial Journal, 14:3-11. 2012.
2. Finkelman, Baylink DJ, Quantitation of growth factors IGF-I, SGF/IGF-II, and TGF-beta in human dentin. J Bone Miner Res 1990;5:717-723.
3. Yeomans JD, Urist MR, Bone induction by demineralized dentine implanted into oral, osseous and muscle tissues. Arch Oral Biol 1967;12:999-1008.
4. Catanzaro-Guimarães SA, Alle N, Osteogenic potential of autogenic demineralized dentin implanted in bony defects in dogs. Int J Oral Maxillofac Surg. 1986;15(2):160-9.
5. Mônica Fernandes Gomes, Densitometric analysis of the autogenous demineralized dentin matrix on the dental socket wound healing process in humans, Braz Oral Res 2006;20(4):324-30.
6. Azar L Cavitation in ultrasonic cleaning and cell disruption. Controlled Environments Feb: 14-17, 2009.
7. Reineke T, Jenni B, Abdou MT, et al. Ultrasonic decalicification offers new perspectives for rapid fish, DNA, and RT-PCR analysis in bone marrow trephines. Am J Surg Pathol 30(7): 892-896, 2006.
8. Bartee BK. Extraction site reconstruction for alveolar ridge preservation. Part 1: Rtionale and materials selection. J Oral Implantol 2001;227: 187-93.
9. Araujo MG, Lindhe J. Socket grafting with the use of autologous bone: an experimental study in the dog. Clin Oral Implants Res 2011;22:9-13.
10. Katz RW, Hollinger JO, Reddi AH. The functional equivalence of demineralized bone and tooth matrices in ectopic one induction. J Biomed Mater Res 1993;27:239-245.
11. Pietrzak WS, Ali SN, Chitturi D, Jacob M, Woodell-May KE. BMP depletion occurs during prolonged acid demineralization of bone: characterization and implication for graft preparation. Cell Tissue Bank 2011;12:81-88.