Case report

Demineralized Tooth Matrix Used as A Bone Graft in Ridge Preservation: A Case Report

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Abstract

Alveolar ridge resorption after tooth extraction is frequent, clinically significant and makes the placement of an implant-supported restoration difficult. Different types of bone substitutes such as xenograft, allograft and hydroxyapatite have been used for ridge preservation. Tooth is a hard tissue with similar organic and inorganic compositions to bone, and thus it could be used as a potential bone graft substitute. In this case report, an autologous demineralized tooth matrix (DTM) was used to preserve and augment the alveolar bone after tooth extraction, before dental implant installation. After 3.5 months, the bone core was trephined for histologic analysis and the dental implant was placed. During the healing period, neither infectious occurrence nor unexpected clinical symptoms were observed. DTM demonstrated good soft and hard tissue contour maintenance. At the time of implant installation, the socket was completely filled with osseous tissue. A histological examination showed new bone formation and resorption patterns of the DTM particles. The clinical and histological findings suggest that filling an extraction socket with DTM is a good alternative for implant site preparation. The results of this case report confirm the resorption of the DTM over time and the formation of quality new bone at the graft site.

Keywords: Demineralized tooth matrix, bone substitute, ridge preservation

Received Date: Jul 14,2016 Accepted Date: Jan 4,2016

doi: 10.14456/jdat.2017.12

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Introduction

The dimensional change of an alveolar ridge is unavoidable over time after tooth extraction and ranges of width and height reduction from 2.6-4.6 mm and 0.4-3.9 mm were confirmed, respectively. In addition, two-thirds of the loss occurred in the first 3 months.[1-3]

The deformities lead to difficulty in the implant placement. However, it is possible to minimize such problems by ridge preservation procedures in the extraction sockets using grafting materials with or without barrier membranes. Ridge preservation has been a proposed method of preserving the tissue contours at extraction sites for later implant placement.[4] Ridge preservation should be considered at the time of tooth extraction if the buccal plate was thin or the socket wall was defective to reduce the need for future ridge augmentation.

Degrees of bone formation and residual graft materials in ridge preservation depends on the materials and techniques used. Various bone graft materials have been reported to minimize the resorption of the alveolar bone at the extraction site, such as allograft, xenograft, and alloplasts. They have been used in an attempt to maintain the dimensions of alveolar ridge after extraction.[5]

The extracted tooth, which is considered as medical waste and simply discarded, is composed of inorganic and organic components in comparable ratio to that of bone. For the inorganic component, tooth has four phases of biological calcium phosphates that interact with each other[6]: hydroxyapatite (HA), tricalcium phosphate (TCP), octacalcium phosphate (OCP), and amorphous calcium phosphate (ACP). Regarding the organic component, the collagenous proteins constitute approximately 90 % of the dentin organic matrix, while the remaining include a small amount of growth factors such as bone morphogenetic proteins (BMP), phosphoproteins, osteocalcins, proteoglycans, and dentin sialophosphoproteins.[7-9] Therefore, there has been more interest in using tooth as a bone graft material. Many studies demonstrated favorable results with osteoconductive and osteoinductive potential from auto tooth bone grafts.[10-13]

In Prince of Songkla University (PSU) bone graft preparation protocol, graft is defatted, decalcified and freeze-dried for the preparation of DTM with a particle size of 500-700 μm. Our previous studies indicated good physiochemical properties and cell biocompatibility. The dentin characteristics from crown and root portion are compared with bone. The XRD patterns in DTM demonstrate high crystallinity which suggesting that the samples consisted mainly of hydroxyapatite crystals. Concerning bioresorption rate compared to bone, the DTM has Ca/P contents, crystallinity degree and crystal sizes similar to that of mineralized bone. In vitro biocompatibility, the particles stimulated cell proliferation. The cultured cells adhered to the surface and exhibited the osteoblast-like features with cell processes extended on a culture plate. (unpublished data).

In this case report, the DTM was made from patient's own extracted third molars. The processed tooth was grafted back to the same patient, so it was safe and had a low risk of the graft rejection. The application of DTM as the bone graft for alveolar ridge preservation was performed at the time of extraction followed by dental implant placement 3.5 months later. The clinical, radiological and histological evaluation were assessed, wherein the implant was successful after a healing period.

A case report

A 31-year-old female patient without any predisposing conditions or systemic disease was referred to the Surgery Department, Faculty of Dentistry, PSU with a chief complaint of a broken tooth without any symptoms. Clinical examination was performed and revealed that tooth 46 had an unrestorable complicated crown-root fracture The orthopanthomograph and periapical film of tooth 46 showed slight alveolar bone resorption without any sign of periapical infection. In addition, wisdom teeth 38 and 48 were found impacted in the jaw bone Treatment options were discussed subsequently and tooth extraction with alveolar ridge preservation before dental implant placement was chosen for replacing tooth 46.

Figure 1 *Complicated crown-root fracture at tooth 46*

Figure 2 *The orthopanthomograph showed wisdom teeth 38 and 48*

When the decision was made to extract a non-restorable tooth, procedures for a socket graft using her own tooth were explained to the patient. Tooth 48 was surgically removed and fabricated into DTM particles.

The DTM was processed following PSU protocol. Briefly, an anatomical crown-root portion of the tooth was dissected in order to totally remove the pulpal tissue. Remaining soft tissues and contaminants were removed and rinsed with distilled water. The cleaned teeth were pulverized into small particles with the sizes of 500-700 μm. The cleaned DTM particles were then defatted, decalcified, and freeze-dried. It was subsequently sterilized using ethylene oxide gas, then packed and stored until the next operation.

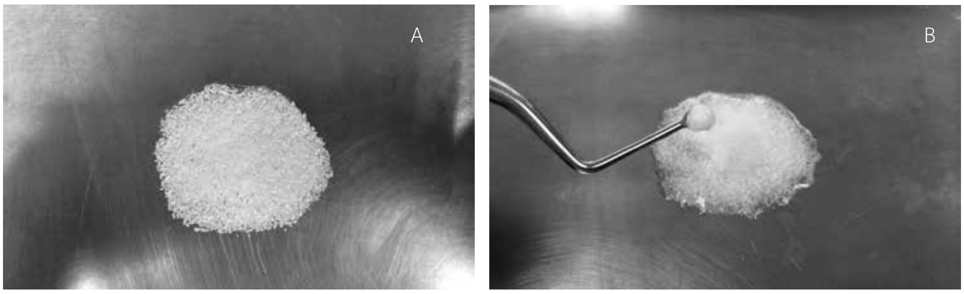

Figure 3 *(A) Preparation of DDM following PSU protocol and (B) Autologous demineralized tooth matrix (DTM) mixed with normal saline*

After the administration of local anesthesia, atraumatic tooth extraction of number 46 was performed with an elevator and forceps. The socket was debrided gently and irrigated with normal saline (Fig. 4A). A thin buccal plate and buccal bone with a dehiscent defect of 3x2 mm were observed. A DTM graft was supplied in the form of particles mixed with normal saline. This made the particles cohesive and allowed for easy placement inside the socket in increments up to the level of the alveolar crest (Fig. 4B). The socket orifice was covered with a palatal mucosal graft, and then sutured by 4-0 Vicryl to stabilize t and let the wound heal by primary intention (Fig. 4C).

Figure 4 *(A) Atraumatic tooth extraction without flap reflection. The thin buccal plate and buccal bone dehiscent defect size 3x2 mm were notified. (B) The extracted socket was filled with DTM particle up to the level of the alveolar crest. (C) The socket orifice was covered with the palatal mucosal graft and sutured with 4-0 vicryl.*

After 3.5 months, the patient returned for implant installation. Clinical examination showed minimal buccal bone resorption with healthy gingival coverage (Fig. 5). Radiographic examination showed an adequate bone height in relation to teeth 45 and 47 and favorable osteoconductive bone healing. Periapical film and cone-beam computed tomography (CBCT) showed that at the time before implant installation, the DTM particles appear harmonious and similar to the adjacent bone. The socket was completely filled with a minimal decrease in volume and change in buccal bone morphology (Fig. 6-7A).

Figure 5 *Three months and two weeks after socket preservation*

Figure 6 *(A) Immediate post-operation after ridge preservation (B) Three months and two weeks after ridge preservation*

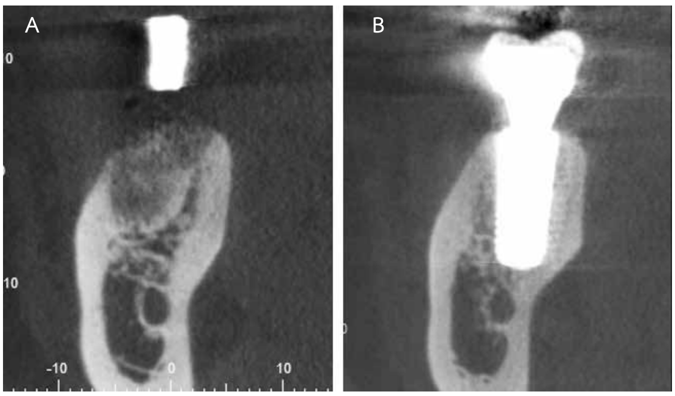

Figure 7 *(A) Cone-beam computed tomography (CBCT) at three months and two weeks after ridge preservation (B) One year after implant prosthesis loading*

The implant type and size were selected based on the anatomy of the implant site and the planned restoration. Full thickness mid-crestal and minimal sulcular incisions were made for tooth 46 and the adjacent area (Fig. 8A). The initial bone drill was performed with a 2x5 mm long trephine bur (TRE020M, Hu-Friedy Mfg Co LLC, Zweigniederlassung, Germany). This allowed for a core of bone, 2x5 mm long, to be obtained. The one stage implant site preparation was performed. An Straumann implant (Institute Straumann AG, Basel, Switzerland) with a diameter of 4.8 mm and length of 12 mm was placed per the manufacturer's protocol. The insertion torque was measured using the Straumann ratchet and torque control device (40 N-cm2). Then an RC healing abutment with conical shape was used (Fig. 8B). Wound closure was performed using 4-0 vicryl. The position of the implant and height of the crestal bone were evaluated on the orthopanthomograph and periapical radiograph immediately after the implant placement (Fig. 9).

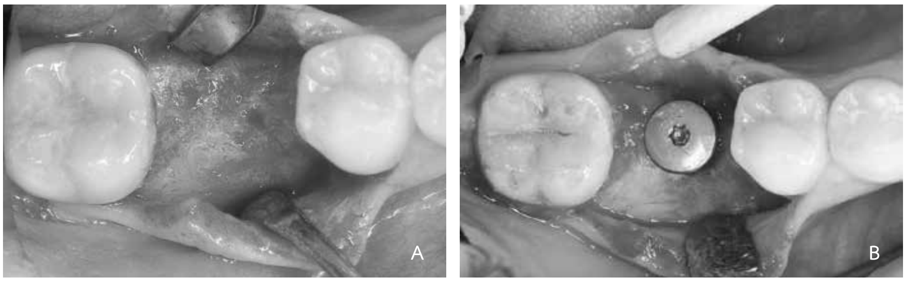

Figure 8 *(A) Full thickness mid-crestal and minimal sulcular incisions were made at the area 46 and adjacent area (B) A 4.8x12 mm bone level RC implant was installed.*

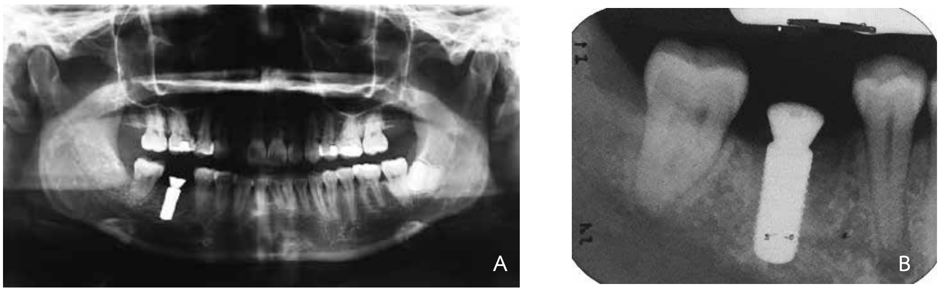

Figure 9 *(A) The orthopanthomograph (B) periapical film of area 46 immediately after one stage implant placement*

Subsequent to the 3-month healing period after the implant placement, prosthodontic construction was performed with a cement-retained prosthesis comprising a straight metal abutment and a semi-precious porcelain -fused-to-metal crown. The location of the finishing line was 1 mm subgingival on the buccal surface and 0.5 mm supragingival on the lingual surface with a lingual metal collar to meet the esthetic and practical needs of the patient. The RC anatomic abutment was tightened into place until 35 N-cm^2 torque was achieved. The crown was set onto a metal abutment and the occlusal-proximal contact was adjusted. The PFM crown was finally cemented with RelyX™ Unicem Self-Adhesive Universal Resin Cement. (Fig. 10) After removal of excess cement, the occlusal contact was checked again. The patient expressed satisfaction with the final result and scheduled for periodic follow-up every 6 months.

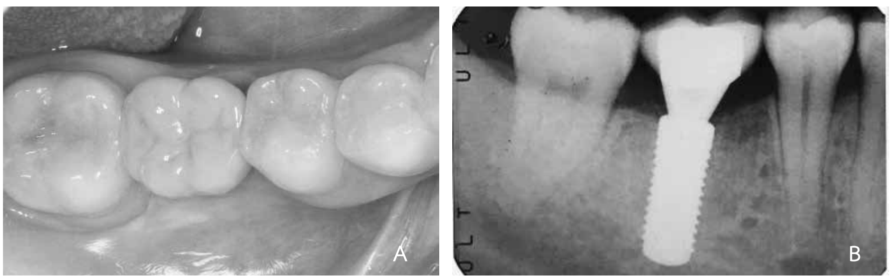

Figure 10 *(A) Final prosthesis, occlusal view (B) periapical film of area 46 after prosthesis loading.*

Although there were not clear expected changes in bone radiographic images before six months, a slightly increased density was observed in the radiographs taken at 3.5-months after the ridge preservation. The success of an implant can also be evaluated by the appearance of normal bone surrounding it. After successful implantation, CBCT was made at regular intervals to assess the success of the implant fixture (Fig. 7B). The bone core histology specimens harvested from the grafted site showed newly formed bone with loose fibrous tissue. The DTM particles were completely mixed with the newly formed bone and old bone. The formation of osteoid was evident around particles. DTM was agglutinated directly with newly formed bone. Furthermore, newly formed osteoid replaced spaces where DTM particles were resorbed (Fig. 11).

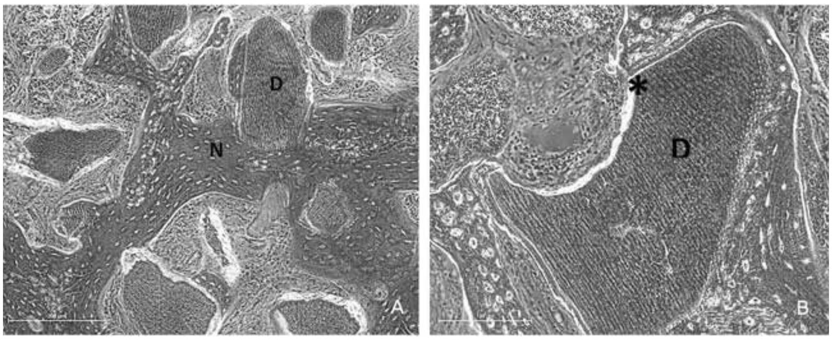

Figure 11 *(A) Newly formed bone (N) and tooth materials showing remodeling were identified around the DTM (D) (H&E stainingX10). (B) New bone may be formed by osteoblasts. The DTM (D) is showing osteoblastic rimming and resorption (*) (H&E stainingX20). Osteoblastic rimming: osteoblast cell lining as show at (*)*

Discussion

The literature demonstrates that ridge preservation should be considered if an implant is to be placed more than six to eight weeks after tooth extraction. If an implant is to be placed at the time of extraction or within six to eight weeks following extraction, there appears to be little benefit in carrying out ridge preservation procedures at the time of extraction. Even when an implant might not be planned in the near future, ridge preservation should be considered in strategic sites to retain the possibility of an implant option for the patient in the future.[5] Ridge preservation should also be considered for aesthetic reasons at pontic sites in conventional fixed prosthodontics.

Since ridge dimensions are so critical, it is important to recognize that post-extraction ridge preservation is essential to ensure maintenance of ideal vertical and horizontal ridge dimensions and contours. Ridge preservation techniques have been proposed by several investigators as possible means to preserve the original ridge dimensions and contours, thereby facilitating optimum implant position and esthetic outcome.[14-17] This may also help avoid additional pre-implant bone grafting procedures. Xenografts, allografts, autografts and synthetic materials used alone or in conjunction with a membrane has been applied immediately following tooth extraction. Among the various materials used are bovine porous bone mineral, demineralized freeze-dried bone allograft, bioactive glass and synthetic resorbable sponge.[18-25]

The socket-seal technique has been demonstrated by Landsberg *et al.*[32] They published an approach containing a gingival graft, which was positioned on the orifice of the extraction socket. A critical point of that study was that DTM needed a sealing material to hold them in place. Therefore, the extraction socket was filled with DTM and sealed with the mucosal graft. After an operation, the healing of the soft tissue graft was improved without any migration of the bone substitute nor any sign of infection.

Various in vitro and in vivo studies have been reported on autologous demineralized dentin matrix (ADDM) regarding its biocompatibility, osteoinductivity, and osteoconductivity.[26-28] From evidence-based ridge preservation techniques, minimal bone resorption seems to be unpredictable. Ridge preservation could minimize the change of bone volume, but could not preclude bone resorption.[1,29] In this case report, the autologous DTM, a newly developed bone substitute, was used at an extraction socket for the future implant site development. There were no post-operative complications related to the grafting materials. The DTM could integrate with the surrounding bone and maintain a stable state around the implant site with minimal buccal bone loss. Based on earlier studies, an autologous tooth bone graft (AutoBT) was resorbed within 4 to 6 months after grafting. The remodeling process with new bone formation continued up to 1 to 2 years.[10,12,29] However, a previous study reported a significant graft resorption. These results might occur from the composition of AutoBT, which was mainly made from roots of the tooth. The root portion consisted of low crystalline calcium phosphate, which is known to have good bony remodeling property[30], but is deficit in volume stability.

In this case report, DTM was fabricated with the different procedures from the previous study.[13,30,31] The DTM particles still include the remaining crown portion or enamel structure of the extracted tooth. The enamel mainly consists of high crystalline calcium phosphate which is not easily decomposed by osteoclasts, resulting in slow resorption and consequently poor osteoconductivity, but hold the socket volume quite well.

With support from the various studies on autogenous tooth as bone graft material, it was confirmed that autogenous tooth is safe and effective. If we can develop the preparation processes to the point that the graft materials can be used in other patients without the risk of immune rejection or disease transmission, it would allow clinician to access an almost unlimited amount of materials. The DTM was further suggested to become more widely used and to be developed into allogenic tooth bone graft materials, ideal scaffold for bone tissue engineering in the future. It is possible to develop a tooth bank where extracted tooth, instead of becoming merely a medical waste, can be kept so that it can be used as bone graft for the patient or even other patients in the future. In order to make the tooth bank concept feasible, further study should be conducted on many areas, such as the appropriate conditions to keep extracted tooth in usable condition, the cost efficient way to run the tooth bank, or the technique to adjust growth factor level in the material.

Conclusion

In this case report, DTM was used as a satisfactory bone substitute alternative because of its good bone remodeling property and its osteoconductivity in ridge preservation of an extraction socket for the implant site development. The implant-supported prosthesis functioned well and healthy peri-implant soft tissue was observed. Further studies need to be done in different bone defect types with a larger sample size, and long-term follow-up is needed to substantiate the validity of DTM.

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