

Tooth Socket Preservation Using Beta Tricalcium Phosphate (β -TCP) Clinical and Experimental Studies

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Abstract:

Alveolar atrophy following tooth extraction remains a challenge for future dental implant placement. Immediate implant placement and post extraction alveolar preservation are 2 methods that are used to prevent significant post extraction bone loss. Immediate extraction site grafting is a simple and straightforward procedure.

Purpose: To determine the efficiency of Resorb β Tricalcium phosphate (β TCP) bone graft material in preservation alveolar bone after tooth extraction.

Materials and Method: Thirty Patients requiring tooth extraction and alveolar bone regeneration for the resulting bone defects by Resorb β TCP (Bone Medik –DM Bone, Biphasic Calcium Phosphate, Synthetic Resorbable material Si-HA (60%): β –TCP(40%) bone graft material were included in this study.

Results: Histopathological examination of the biopsy specimen showed new bone deposition. Radio graphical radio densities of the regenerated bone were evident in treated sockets during the follow up period. Statistical analysis indicated that the healing percentage was 70%-80% in 13 patients and the main among 25-35 age group.

Conclusions: Resorb β Tricalcium bone graft material was successful material in reconstruction of bone defects following tooth extraction when compared with other graft materials.

Key word: β TCP :Beta Tricalcium phosphate

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Introduction:

Dimensional changes after tooth extraction often result in bone resorption that complicates restorations with implant or traditional prostheses. Preservation of alveolar dimensions after tooth extraction is crucial to achieve optimal esthetic and functional prosthodontics results. In addition, with the increasingly frequent use of dental implants to replace nonrestorable teeth, preservation of the existing alveolus is essential to maintain adequate bone volume for placement and stabilization of the implants. A traumatic extraction and socket preservation techniques have been introduced to minimize bone resorption after tooth extraction ⁽¹⁾.

After tooth extraction, the residual alveolar ridge generally provides limited bone volume because of ongoing progressive bone resorption. Healing events within post extraction sockets reduce the dimensions of the socket over time. A reduction of about 50% in both horizontal and vertical directions has been observed over 12 months, with two-thirds of the reduction occurring in the first 3 months. In addition, the result of tooth removal is shrinkage of the bone at the extraction site, with a subsequent loss of 40% to 60% of the height and width within 2 to 3 years, followed by an average loss rate of 0.5% to 1.0% per year for life ⁽²⁾.

The rate and pattern of bone resorption may be altered if pathologic and traumatic processes or periodontal have damaged one or more of the bony walls of the socket⁽³⁾. In these circumstances, fibrous tissue will likely occupy part of the socket, preventing normal healing and osseous regeneration. These morphologic changes may affect the successful placement and Osseo integration of dental implants. When considering ways to preserve adequate bone volume, clinicians frequently ask whether filling bone defects, such as alveolar post extraction sockets, with Resorbable osteoconductive materials is warranted. Although autogenous bone is still considered the gold standard for grafting procedures, limitations, such as donor site morbidity. Bone graft harvesting techniques, have stimulated the search for suitable synthetic grafting materials. Although barrier membranes may be used to guide bone regeneration, wound dehiscence may lead to early exposure and infection of the membrane followed by reduction in the volume and quality of bone⁽¹⁾⁽⁴⁾. Socket grafting is a procedure designed to rebuild the bone in order to allow tooth replacement by implant or bridge restoration. The bone surrounding a tooth socket is a special type which will deteriorate very quickly after a tooth is removed. If a socket remains empty after a tooth is lost or extracted the accelerated bone loss in the area can also negatively impact any adjacent teeth. Therefore it is very important for health and esthetics to rebuild the socket as soon as possible after tooth loss or extraction. After the extraction of teeth, there is resorption of the alveolar ridge resulting in loss of height and width. The reduction in width occurs primarily on the buccal side of the edentulous ridge, creating a potential esthetic problem for prosthetic or implant dentistry⁽⁵⁾. Today, using socket preservation techniques, it is possible to

preserve the height and width of the edentulous ridge. This is particularly important for placement of dental implants allowing for more ideal placement for the final esthetics with improved emergence profile and gingival architecture. The challenge for the dentist is to preserve the quantity and quality of the gingival and osseous tissues. Additionally, the procedures used should achieve these goals but not create any significant future problems. For example, primary closure was used in many of the early attempts to preserve the alveolar ridge. Although it did help retain and protect the graft and/or barrier membrane that was placed, there often was a decrease in papillae height and keratinized gingiva. The techniques available today are based on the principle of guided bone regeneration, which has been used in periodontal regeneration since 1982. The technique consists of isolating a bony space, in this case an extraction socket with a barrier membrane, to exclude the epithelial cells and thereby have the space fill with bone. The technique has been used with and without a bone replacement graft⁽⁴⁾⁽⁶⁾. The placement of a barrier membrane without a bone replacement graft reduces ridge resorption. The use of a bone replacement graft alone results in some preservation of alveolar height and width but less than with a barrier membrane. The use of a barrier membrane plus a bone replacement graft has been shown to be superior to a bone graft or barrier membrane alone. The characteristics of the bone replacement graft and the barrier membrane greatly affect the final result. The other factors that are critical for the preservation of the alveolar ridge at the time of tooth extraction are the extraction technique and the flap design. A traumatic extraction techniques should be used with attempts to preserve all of the remaining alveolar bone adjacent to the tooth. The elevation of

buccal lingual flaps, which are often needed in the extraction of badly broken-down teeth, will result in some loss of adjacent papillae height. Resorb β TCP is known to be highly biocompatible, Resorbable and osteoconductive. Due to these properties, Resorb β TCP is currently used in many surgical and dental applications in order to heal or augment bone defects. In situ, Resorb β TCP is mainly replaced by newly formed bone within 6 to 24 months postoperatively. Beta-Tricalcium phosphate (β -TCP), a synthetic alloplastic material, has been used for bone regeneration in a variety of surgical procedures with satisfactory clinical and histological results in both animal models and human trials. β -TCP may be a suitable bone substitute that will biodegrade and be replaced by newly mineralizing bone tissue without fibrous tissue proliferation. Bony regeneration has been reported in cases where β -TCP was used without a barrier membrane in patients undergoing sinus floor elevation and mandibular cyst removal. The material has no organic components, therefore, no chance of antigenicity and allergic reaction. As the material synthesized in laboratory any possible infectivity is removed. There has been recent concern of disease transmission from allografts and xenografts. Using this alloplastic material prevents this possibility, eliminating the surgeon and the patient apprehension. Chemically the graft has similar composition to salt. Because the chemical composition and high purity of the material there is no cytotoxic compound released during the breakdown of this material. Compared with autogenous graft, the graft material has unlimited availability without the postoperative morbidity from harvesting procedure. Studies have demonstrated preservation of alveolar dimension after extraction and socket grafting(7)(8). It is also possible to combine β -TCP with

platelet rich plasma, other growth factors or collagen to potentially accelerate the process of bone regeneration.

Resorb β TCP was evaluated without discerning possible influences of phase purity of granules size on the results or on the degradation rate.^{(9) (10)} Osteoconduction properties is the process that provides an inert scaffold or physical matrix suitable for the deposition of new bone. Osteoconductive grafts which are often inorganic, allow bone apposition from existing bone or encourage differentiated mesenchymal cells to grow along the surface but it does not produce bone formation when placed in soft tissue. Tricalcium phosphate (Resorb β TCP), an alloplastic ceramic material studied and used extensively in the past decades.(11) It is considered to be bioactive (by means of inducing specific biologic reactions) and biocompatible (not stimulating inflammatory or foreign-body giant cell activity). This is mainly because Resorb β TCP is composed of Ca and P ions, which are the most commonly found elements in bone. However, Resorb β TCP cements have a slower resorption rate than bone and are usually too dense to allow bone tissue to grow into the defect in a limited period of time. By adding a faster resorbing material, pores may be created, ensuring new bone tissue growing into the defect.

Materials and Method:

Sample:

Thirty patients (15 - 50) years of age. Male 18% and 13% female. Attended to Al Anbar college of Dentistry/Department of Oral and Maxillofacial surgery(2012-2013) requiring teeth extraction under local anesthesia and socket preservation for the resulting bone defects with β TCP bone graft material for subsequent implant placement, bridge and prosthetic reconstruction. Another experimental study included 5 rabbit were anesthetized by i.p

ketamine 10% and a bony defects were made over its mandibular anterior region and filled with β -TCP graft material for histopathological examination.

Methods: The procedure is done by using Resorb Beta Tricalcium phosphate TCP (Bone Medik –DM Bone, Biphasic Calcium Phosphate , Synthetic Resorbable material Si-HA (60%): β -TCP(40%) bone graft material.

The extraction procedure were performed under local anesthesia. Preapical radiographs were taken preoperatively. The extraction of the tooth conducted as gently as possible to minimize the possible extraction trauma using suitable size dental extraction forceps and elevators. The socket should be thoroughly cleaned from the granulation tissue using surgical curetted and irrigated with normal saline . The Resorb beta Tricalcium phosphate (Bone Medik –DM Bone, Biphasic

Calcium Phosphate ,Synthetic Resorbable material Si-HA (60%): β -TCP(40%) bone graft material alloplastic material) is used to fill the extraction socket. The flap gently replaced and sutured over the filled socket .The patient was prescribed a course of antibiotics and analgesics (Ampicillin 250mg + Cloxacillin 250 mg IV/Paracetamol 500mg)*2 daily for 1 week. The area were followed clinically and radiographs were taken after 1 weeks and 1 month after tooth extraction. Another experimental study included.5 Rabbits were anesthetized using i.p ketamine 10%,a bony defects were created over the mandibular anterior region and were filled by Resorbable β -TCP graft material and used for histopathological examination. The rabbit were sacrificed after one month and biopsies of were taken and placed in 10% formalin and sent for histopathological examination.



Figure (1): Patient 50 y old with severely resorbed maxillary ridge, extraction of right maxillary lateral incisor. The socket is filled with graft material



Figure(2): B-TCP bone graft material filled the extracted tooth socket of maxillary left lateral incisor tooth



Figure(3): Bone graft material filling the extracted socket of maxillary right canine tooth.



Figure (4):Grafted tooth sockets after suturing with 3/0 black silk suture.



(b)

Figure(5):(a)Preoperative picture for patients with severe resorption.(b)Showing the teeth sockets after extraction of teeth.



Figure(6):Graft bone material fill the extracted teeth sockets



Figure(7):Suturing of the grafted sockets with 3/0 black silk suture.

Results:**Statistical analysis: 1.**

The result of our study show that all the treated socket heals uneventually with no complications.



Fig.1. Healing percentages versus ages.

Table 1: The Cross-Classification of Healing Percentages Groups Versus Age Groups

healing groups	age groups <25	age groups 25-30	age groups 30-35	age groups 35+	Row - Totals
50-60%	0	0	0	5	5
60-70%	0	1	4	1	6
70-80%	1	4	6	2	13
>80%	4	0	2	0	6
All Groups	5	5	12	8	30

Table 2: Spearman Rank Order Correlations.
Marked correlations are significant at $p < .05000$

	healing groups	age groups
healing groups	1.000000	-.0666
age groups	-.0666	1.000000

The healing percentages are negatively correlated with age Figure (2). This is actually a very obvious process since young people have the ability to substitute their damaged tissues in less time average comparing to those in advanced age groups. The scattering points of the graph indicates that this is not a constant behavior since people may be exposed to infection or other factors that affect tissue substituting and have to be investigated separately to control good management of patients.

Table1 shows that 12 patients of those aged between 25-35 have a healing percentages ranged between 70 up to more than 80%. Six patients out of 8 patients (75%) age 35 years and more, found to have on between 50-70% healing

percentages. This is obviously indicates the effect of age on the healing process. The Spearman rank order correlation emphasize that the relationship between age and healing process is negatively significantly correlated (table 2).

2.Radiographical examination:

Radiographical examination after the 1 month follow-up ,the alveolar sockets appeared to be filled with radiodense bone tissue .



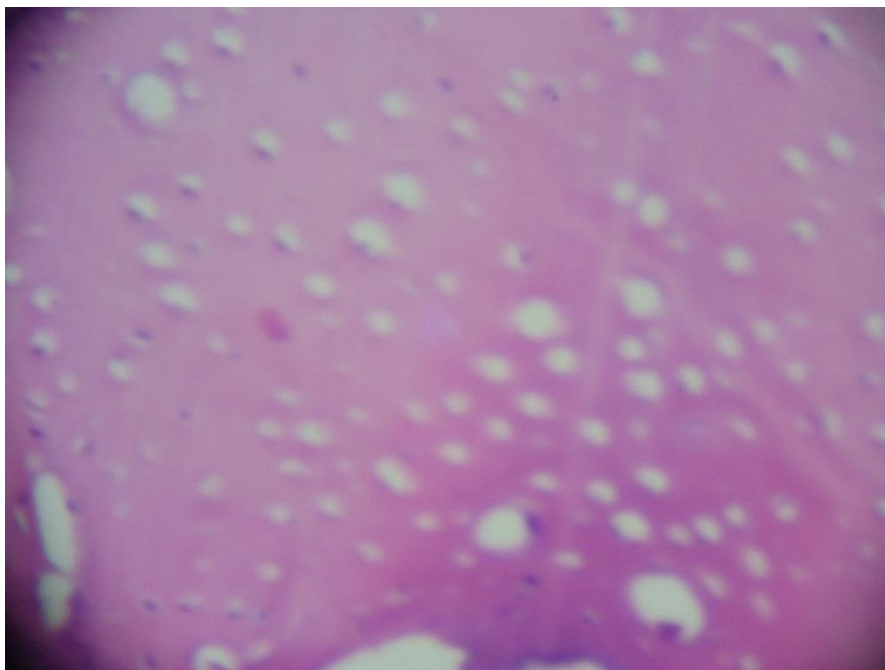
Figure(1): Postoperative Preapical X-ray radiograph showing the radiopacity of the bone graft material after 1 week



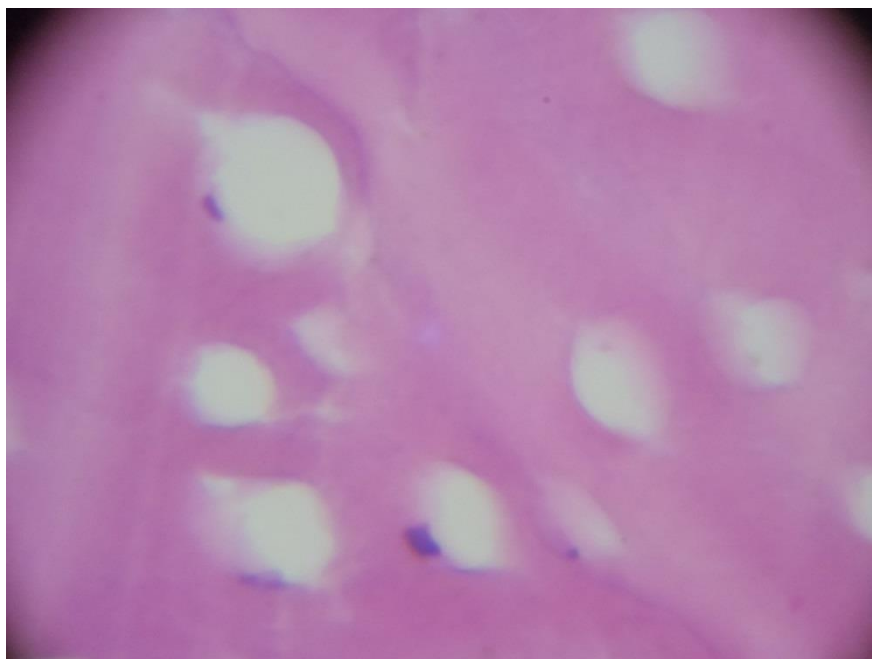
Figure(3): Periapical X-ray showing the Radiographical radiopacity of the grafted sockets after extraction of mandibular anterior teeth after 1 month

3.Histopathologically:

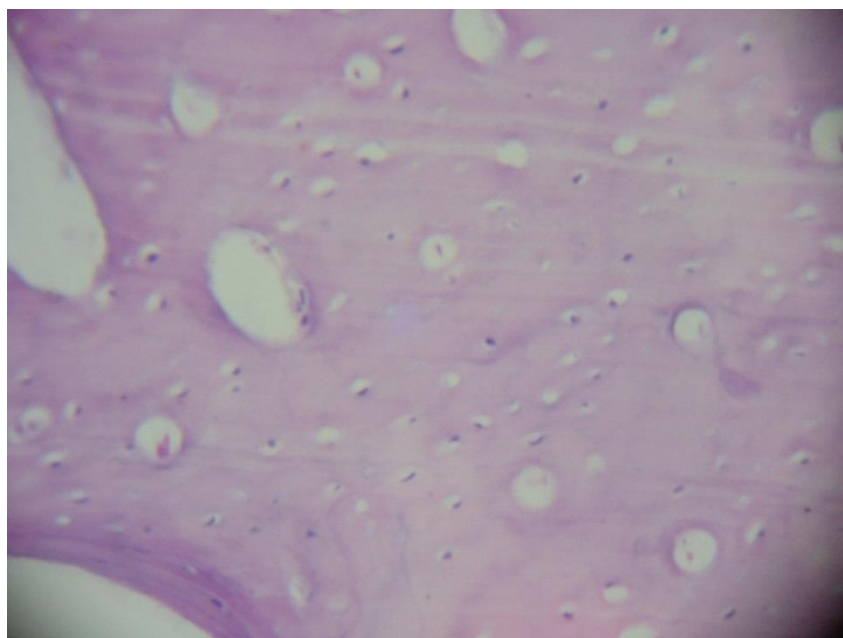
Histopathological examination of the sockets filled Resorb β TCP show complete resorption of the bone graft material and evidence of new bone formation(osteoid) after 1 month.



Figure(1):Showing the ossification and formation of osteoid tissue after 1 month 40 X



Figure(2):Showed the vital bone after 1 month . Arrow indicate Osteocyte.



Figure(4):Histopathological slide showing the ossification and formation of osteoid tissue after 6 weeks.40 X

Discussion:

There are several reasons to consider preservation of the alveolar socket immediately following tooth extraction. One reason for placing a graft of a synthetic biomaterial is to stabilize the coagulum within the socket and avoid possible reduction of the hard tissue volume required for bone regeneration. Although vertical bone resorption can be expected as part of the physiologic pattern of bone healing after tooth extraction. Another reason for placing a graft into an extraction socket is to provide a scaffold for the in-growth of cellular and vascular components to form new bone of acceptable quality and quantity ⁽⁶⁾.

According to Table(1), 13 patients (43.33%) showed healing process ranged between 70%-80%. The vast majority of those patients were in the age groups 25-35 years which indicates the greater osteogenic capacity of the patients. These results were found in agreement with that of ⁽⁸⁾, the property of β -TCP graft is safety, efficiency, and the ability of the graft material to be replaced by vital alveolar bone. The Resorb β -TCP used in his study is fabricated as pure synthetic material to exact chemical specifications. Porosity of the graft material, both macroscopically and microscopically, is designed to maximize the clot stability during healing. These studies showed no treatment of socket resulted in a collapse of the alveolus by 29% and grafting the socket at the time of extraction resulted in a bone loss of only 13%. ⁽⁷⁾ emphasize that the all of the findings of this underment study are in agreement with their findings and so this research work approach similar results. After averaging ridge width changes, it was noted that there was a 35.2% loss of bone volume in the buccolingual dimension.

Similar evidence of socket collapse after placement of immediate socket dental implants questions the use of this technique to preserve alveolar bone volume. The results of this current study clearly demonstrate a significantly better of alveolar ridge dimension than the placement of an immediate socket dental implant with no grafting. Other dental research has demonstrated vital bone fill in extraction sockets with other techniques and materials. Radioarphical examination of treated sockets show evidence of radiodense bone tissue which is consistent to studies conducted ⁽¹²⁾⁽⁸⁾, found that resorb β -TCP disintegrate eventually and will fully convert to vital alveolar bone after the end of the study period. Other bone graft materials that are radiopaque at the time of insertion are resorbed minimally, if at all, during this period, giving the surgeon no clue as to the amount of biologic healing that is occurring. In contrast, Resorbable materials change radiopacity to appear like normal trabeculated bone as they heal. An advantage of resorb β -TCP is that it will break down clinically in the appropriate time to place a dental implant in the grafted sites. The sites grafted with β -TCP exhibited a decreased amount of bone loss as compared to nongrafted sites. The use of a Resorbable bone-replacement graft material eliminates the possibility of delayed alveolar socket healing, prevents residual graft particles from interfering with osseointegration, and allow complete fill of the socket (or other treated site) with vital alveolar bone ⁽¹³⁾⁽⁷⁾.

Conclusions:

It was concluded from this study that Resorb β -TCP is a useful bone replacement graft material at the time of tooth extraction. Clinical observations showed preservation of alveolar bone, and

histological analysis demonstrated both resorption of the graft material and conversion to vital alveolar bone. These characteristics make this graft material ideal for use after tooth extraction in conventional and implant dentistry. This study indicate that there is complete regeneration of all sockets grafted with β TCP .

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