Original Article

Evaluation Of Effect Of Beta-Tricalcium Phosphate With Platelets Rich Fibrin On Alveolar Ridge Post Extraction

Wisam Mbarak Allafi Jouliq*[1], Atef Mohamed Hassaneen[2], Abd El-Moneim Abdullah Abd El-Ghafar[3]

1.B.D.S. 2014-2015G, Faculty of dentistry, Zawia university, Ministry of health, Libya
2.Assistant Professor, Department of oral and maxillofacial surgery, Faculty of dental medicine, Boys, Cairo, Al-Azhar university
3.Professor, Department of oral and maxillofacial surgery, Faculty of dental medicine, Boys, Cairo, Al-Azhar university

Corresponding author: Wisam Mbarak Allafi Jouliq
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Abstract

Objectives: The aim of this study was done to evaluate the efficacy of beta-tri-calcium phosphate and platelet-rich fibrin on alveolar ridge for socket preservation after tooth extraction radiographically. **subjects and methods:** Forty patients with permanent tooth indicated for extraction divided into four groups .Group I: (The control group) socket will leave heal spontaneously, Group II: Sockets will fill with beta-tricalcium phosphate alone, Group III: Sockets will fill with PRF alone, Group IV: Sockets will fill with beta-tricalacium phosphate and PRF. The patients were evaluated for pain, swelling, infection, bone height, width, and density. **Results:** the lowest decrease in bone width is combination group followed by Beta-TCP group followed by PRF. there was increase in bone density in each group and more in the combination group and decrease bone loss in compare with control group. **Conclusion:** The use of Beta-TCP with PRF was effective in socket preservation, reduces the need for future ridge augmentation to obtain optimal, functional, and esthetic results.

Keywords Beta-tricalcium phosphate, extraction socket, platelet-rich fibrin.

Introduction

After tooth extraction, natural bone remodeling is carried out, with volumetric alveolar bone reduction, a loss in horizontal bone and a vertical bone, this phenomenon may compromise the restoration of missing teeth with dental implants [(1)] Preserving the alveolar ridges at the time of tooth extraction help to minimize difficulties subsequent implant, The most predictable way to maintain the width, height, and position of the alveolar ridges in preservation at the time of tooth extraction [(2)]

Various bone-grafting and bone substitute materials have been used for ridge preservation procedures, include autologous bone grafts, allografts, bone of animal origin (xenografts) and synthetic bone substitutes (alloplastic grafts), as well as the application of growth factors and gene therapies [(3).] Several types of bone subsitutes are commercially available, including allografts, xenografts, and alloplasts.[(4)] Beta-tri-calcium phosphate (beta-TCP) is widely used as a biocompatible, resorbable and osteoconductive ceramic substitute to repair bone defects. It has also been proposed as a vehicle for growth factors that stimulate bone formation. Various authors have reported on its capacity as a biomaterial for bone regeneration in animals and humans [(5)]

Platelet-rich fibrin (PRF) which is a second-generation platelet concentrate. Since then, it has been used for the management of intrabony defects, sinus lift techniques for implant placement and coverage of recession defects in the form of a membrane [(6)]. PRF is a viable and biocompatible autologous biologic material that can be used alone to maintain ridge dimension during preservation procedures while at the same time stimulating rapid osseous fill of the socket [(7)] This study aimed to evaluate effect of beta-tricalcium phosphate and PRF on alveolar ridge post extraction.

SUBJECTS AND METHODS

Study design

Randomize controlled, clinical trial (RCT).

Study population

Fourty patients were included in this study. They were selected from those attending the outpatient clinic of oral and maxillofacial surgery department Faculty of Dentistry, Al-Azhar University (boys- Cairo). The age was ranged from 18-40 years. They were complaining of badly broken Unrestorable lower molar teeth, all patient had at treatment plane for extraction of these teeth.

Inclusion criteria

Healthy Patients free from systemic diseases; this will be verified by a physician. Presence of a hopeless in lower tooth requiring extraction.

Exclusion Criteria

Uncontrolled any systemic disease which could affect the healing, e.g.: Diabetic Patient, patient on chemotherapy, radiotherapy. Presence of any local acute suppurative infection or pathosis at the time of teeth extraction. Anticoagulant therapy that could impair platelet function. Uncontrolled or untreated periodontal disease.

Sample size and grouping

Forty patients indicated for lower molars teeth extraction were selected for this study**.** Based on power test of previous study [(10)] (power test 95%, effect size was 3.1 and significance level= 0.05).

There was randomly divided into four groups. Group I: (The control group) socket was leave empty (N=10). Group II: Sockets were filled with beta-tricalcium phosphate alone (N=10). Group III: Sockets were filled with PRF alone (N=10). Group IV: Sockets were filled with beta-tricalacium phosphate and PRF (N=10).

Ethical Considerations (543/3096), All patients were informed about:The surgical procedure.Complications. Post-operative follow-up period. Each patient was signed an informed consent form after he/she has received detailed information about the study before starting the study.

Surgical procedure (fig (1)

The patients were asked to rinse his/her mouth thoroughly for 30 seconds with 0.12% Chlorhexidine mouthwash[*] 2 minutes prior to surgery. Topical anesthesia gel was applied before local anesthesia. Local anesthesia was achieved by administration of 2% Mepivacaine[**] HCl with 1:20,000 Levonordefrin by nerve block technique. After profound anesthesia was achieved and extraction was done. Extraction was carried out to the tooth without damaging the surrounding bone to preserve the socket size in all patients. Socket debridement and gentle curettage was done to remove and eliminate the any periodontal ligament fibers using a sharp curette and copious.

Beta-tricalcium phosphate preparation

Bone graft material (Beta-Tri calcium phosphate small granules) were mixed with normal saline together in a sterile dish and then filled into the socket. After that, the socket was sutured with figure eight suture approximate edges of extraction site using non-absorbable silk suture size 3/0.(figure 9,10&11) After that, cone beam CT (CBCT) was done immediately after suturing. (Figure 12)

Blood centrifuge

As in the study group, preparing the venipuncture at the area of cephalic vein at antecubital fossa it was scrubbed using alcohol swab at least 30 seconds and applied the tourniquet, then ten millimeters of blood was collected from the patient in 2 tubes.The tubes were immediately placed in the centrifuge with appropriate balance by putting the tubes opposite to each other. The RBC layer at the bottom of the tube, the dense PRF clot forms at the intermediate layer, in which most of the platelets and leucocytes from the harvested blood are concentrated. The top layer which is liquid serum called platelet-poor plasma (PPP). With a sterile tweezer the PRF which is obtained was collected to place into

the socket (Figure 16) after that, the socket was sutured with figure eight suture approximate edges of extraction site using non-absorbable silk suture size 3/0. After that, cone beam CT (CBCT) was done immediately after suturing.

Beta tri-calcium phosphate in combination with platelet rich fibrin PRF.

The PRF and BETA tri-calcium phosphate were mixed together in a sterile dish and then filled into the socket. After that, the socket was sutured with figure eight suture approximate edges of extraction site using non-absorbable silk suture size 3/0. (Fig. 20&21). After that, cone beam CT (CBCT) was done immediately after suturing. (Figure 22)

Group I: (The control group) socket was leave empty (N=10). Group II: Sockets were filled with beta-tricalcium phosphate alone (N=10). Group III: Sockets were filled with PRF alone (N=10). Group IV: Sockets were filled with beta-tricalacium phosphate and PRF (N=10).

Postoperative evaluation:

Clinical evaluation: All patients of the 4 groups were evaluated at second, ^{5th}, 7^{th} and 10^{th} day's post-operative to evaluated for pain, swelling, infection.

Radiographic evaluation: All patients of the 4 groups were evaluated immediately and after 6^{th} months through cone beam computed tomography (CBCT) to evaluate the following (Figure 23,24,25&26): Bone width in a buccolingual direction. Bone height from the deepest point of the socket to the highest point. Bone density via bone density window in the software.

Statistical analysis

After 6 months of surgery the patient were re-evaluated of bone height, width, density of lower molar tooth. Data were compared using independent t test or Mann Whitney U test according to normality. The level of significance were set at $P < 0.05$. All tests will be two tailed.

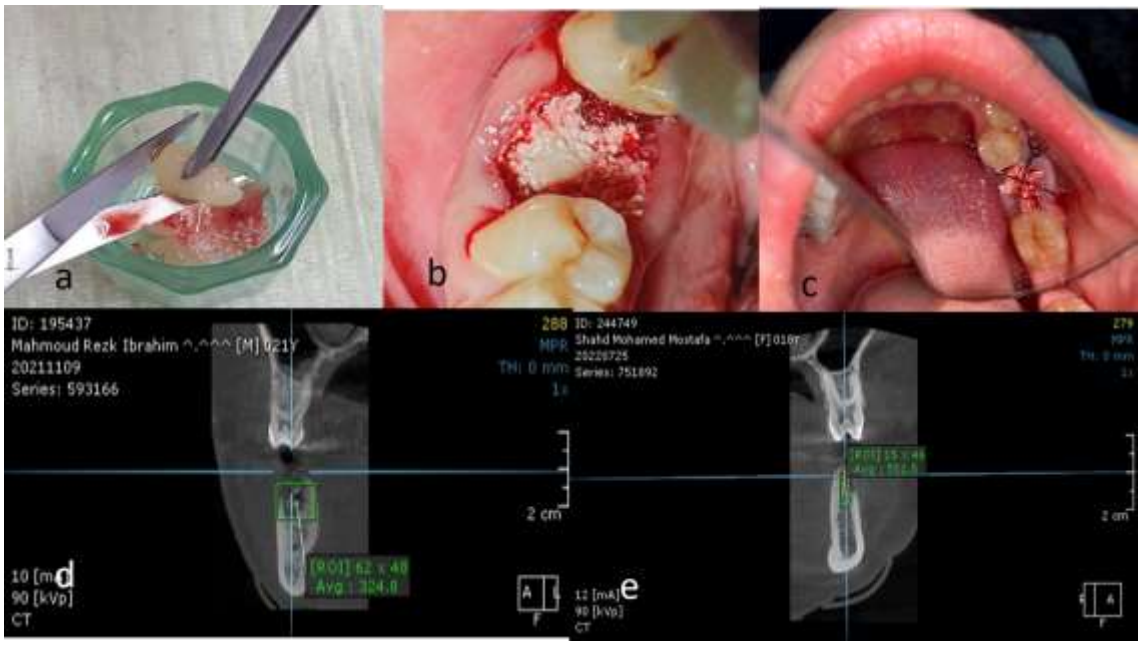

Figure (1): a, The PRF and BETA tri-calcium phosphate were mixed together in a sterile dish, b, The mixture of PRF and BETA tri-calcium phosphate were filled into the socket, c, suturing, d, bone height, width, density of lower molar tooth immediately after suturing, e, after 6 months

RESULTS

Table (1): Comparison between the different studied groups according to pain. At Day of procedure to Day 2, PRF group showed a significant decrease in Pain (2.60 ± 0.55) Followed by Beta-TCP/ PRF group (p=0.003* and 0.002*). At Day 5 to Day 7, there was a statistically non-significant differences between groups (p=0.067, and 0.191)

Table (1): Comparison between the different studied groups according to edema. At Day of procedure to Day 7, there was a statistically non-significant differences between groups (p=0.071, 0.087, 0.081 and 0.071)

Table (1):Comparison between the different studied groups according to pain and edema

	Control	Beta-TCP	PRF	Beta-TCP/ PRF	p
Pain					
Day of procedure	3.80 ± 0.45	5.60 ± 1.34	2.60 ± 0.55	3.40 ± 0.55	0.003*
p_0		0.105	0.039*	0.434	
Sig. bet. grps.		p_1<0.001*,p_2=0.016*,p_3=0.198			
Day 2	3.80 ± 0.45	5.60 ± 0.89	2.60 ± 0.55	3.40 ± 0.55	0.002*
p_0		0.104	0.038*	0.432	
Sig. bet. grps.		p_1<0.001*,p_2=0.016*,p_3=0.197			
Day 5	0.80 ± 0.45	1.40 ± 0.55	0.40 ± 0.55	0.80 ± 0.45	0.067
Day 7	0.40 ± 0.55	0.40 ± 0.55	0.0 ± 0.0	0.0 ± 0.0	0.191
Edema					
Day of procedure	12.04 ± 0.45	11.30 ± 0.36	11.25 ± 0.50	11.49 ± 0.59	0.071
Day 2	12.11 ± 0.46	11.41 ± 0.37	11.31 ± 0.53	11.55 ± 0.58	0.087
Day 5	12.08 ± 0.46	11.37 ± 0.37	11.27 ± 0.52	11.53 ± 0.58	0.081
Day 7	12.05 ± 0.45	11.31 ± 0.36	11.25 ± 0.50	11.50 ± 0.59	0.071

Data was expressed using Mean ± SD.
H: H for **Kruskal Wallis test,** Pairwise comparison bet. each 2 groups was done using **Post Hoc Test (Dunn's for multiple comparisons test)**
p: p value for comparing between the studied groups
p_0: p value for comparing between **Control** and each group
p_1: p value for comparing between **Beta-TCP** and **PRF**
p_2: p value for comparing between **Beta-TCP** and **Beta-TCP/ PRF**
p_3: p value for comparing between **PRF** and **Beta-TCP/ PRF**
*: Statistically significant at $p \leq 0.05$

Radiographic evaluation

Table (2): Comparison between the different studied groups according to bone height. At Baseline and 6 months, there was a statistically non-significant differences between groups (p=0.632 and 0.193) respectively. % Reduction, there was a statistically non-significant differences between groups (p=0.169).

Bone width

Table (2): Comparison between the different studied groups according to bone height. At Baseline, there was a statistically non-significant differences between groups (p0.444). % At 6 months, there was a statistically a significant difference between groups (p=0.017*). Beta-TCP/ PRF showed the lowest decrease in bone width (2.63 ± 5.21) followed by Beta-TCP group followed by PRF. The highest bone reduction was in control group (27.82 ± 7.58)

Bone density

Table (2): Comparison between the different studied groups according to bone density. At Baseline, there was a statistically a significant difference between groups ($p=0.010^{*}$). At 6 months, there was a statistically a significant difference between groups ($p<0.001^{*}$). Beta-TCP/ PRF showed the highest bone density (620.0 ± 31.02) followed by Beta-TCP group (466.0 ± 38.24) followed by PRF (336.6 ± 66.65). The lowest bone density was in control group (318.6 ± 97.32)

Table (2): Comparison between the different studied groups according to bone height, Bone width, and Bone density

	Control	Beta-TCP	PRF	Beta-TCP/ PRF	p
Bone height					
Baseline	11.64 ± 1.70	12.38 ± 0.88	11.88 ± 1.69	12.92 ± 2.11	0.632
6 months	10.44 ± 0.93	11.52 ± 0.82	10.84 ± 1.68	12.48 ± 2.15	0.193
% Reduction	9.62 ± 7.41	6.89 ± 3.56	8.88 ± 1.91	3.51 ± 2.65	0.169
Bone width					
Baseline	8.78 ± 1.26	8.80 ± 1.10	9.48 ± 1.65	10.08 ± 1.65	0.444
6 months	6.40 ± 1.52	7.86 ± 0.78	8.12 ± 1.90	9.78 ± 1.39	0.017^{*}
p_0		0.412	0.278	0.010^{*}	
Sig. bet. grps.		$p_1=0.992, p_2=0.306, p_3=0.198$			
% reduction	27.82 ± 7.58	10.45 ± 2.79	15.02 ± 5.96	2.63 ± 5.21	$<0.001^{*}$
p_0		0.001^{*}	0.012^{*}	$<0.001^{*}$	
Sig. bet. grps.		$p_1=0.589$, $p_2=0.169$, $p_3=0.015^{*}$			
Bone density					
Baseline	139.4 ± 38.80	255.0 ± 90.76	209.0 ± 57.49	287.8 ± 49.46	0.010^{*}
p_0		0.044^{*}	0.326	0.008^{*}	
Sig. bet. grps.		$p_1=0.656, p_2=0.839, p_3=0.230$			
6 months	318.6 ± 97.32	466.0 ± 38.24	336.6 ± 66.65	620.0 ± 31.02	$<0.001^{*}$
p_0		0.011^{*}	0.970	$<0.001^{*}$	
Sig. bet. grps.		$p_1=0.026^{*}, p_2=0.008^{*}, p_3<0.001^{*}$			

Data was expressed using Mean ± SD.

F: **F for One way ANOVA test**, pairwise comparison bet. each 2 groups were done using **Post Hoc Test (Tukey)**

p: p value for comparing between the studied groups
p_0: p value for comparing between **Control** and each group
p_1: p value for comparing between **Beta-TCP** and **PRF**
p_2: p value for comparing between **Beta-TCP** and **Beta-TCP/ PRF**
p_3: p value for comparing between **PRF** and **Beta-TCP/ PRF**
*: Statistically significant at $p \leq 0.05$

DISCUSSION

Extraction socket preservation (ESP) is widely performed after tooth extraction for future implant placement. For successful outcome of implants after extractions an autogenous bone graft is considered the gold standard in maxillofacial surgery because of its osteoinductive and osteoconductive features and the fact that it does not cause immunological problems.[8] The present study was designed to investigate bone healing in standard defects filled with PRF and β-TCP alone or in combination in the socket.

In the our study we used platelet rich fibrin PRF because it does not contain any synthetic or anticoagulant materials. With this simplified technique, it is cheaper to prepare and the production time is shorter. an autologous fibrin matrix, which contains platelets and leucocyte growth factors. [9] In the other hands we used in these study beta tricalcium phosphate β-TCP as these alloplastic materials has the properties of high biocompatibility and osteoconductivity. Because of these features, β-TCP leads to bone apposition in the areas contacting with the material.[10]
The most frequent sites of attack are the occlusal surfaces of the first and second permanent molars. so, in this study, we chosen the lower posterior molars because the lower molars were the most severely affected teeth and susceptible to caries in the entire dentition, more commonly affected than upper molars.[11]

The pain was evaluated through visual analog scale VAS, the patients were evaluated for 7 days after the procedure and were prescribed an analgesic, in the study group the patients experienced slight to moderate pain. But in comparison between two groups there was statistically non-significant difference in mean VAS in both groups due to patient's discipline of the post-operative instruction and improvement of oral hygiene and atraumatic extraction. The present study showed no infection and dehiscence in each groups and no inflammation signs in the patients which is agreed with Tang et al[12], in his study to evaluate the efficacy of MPM in management of dehiscence defect around dental implant in narrow maxillary anterior ridge. The overlying mucosa was examined for any signs of inflammation, infection or dehiscence at monthly intervals until six months.the results showed the overlying mucosa did not show any signs of inflammation or infection.

The patients were covered with antibiotics which is agreed with Sakkas [13].When they planned to place an implant in upper left canine area, they found that there was a soft tissue deficiency and a significant labial bone loss and remaining root. Immediate implant placement was not possible, so extraction and socket preservation using PRF& β-TCP was planned, the patient was followed after ten days and four months. Which revealed excellent soft tissue healing and fully keratinized gingiva. In each groups there were statistically non-significant difference in swelling measurement and no swelling in the each groups, Sakkas et al [8] evaluated the effect of MPM on new bone formation in maxillary sinus lifting procedure, and the patients were followed after 2 days until 2 weeks. The results showed no post-operative edema or swelling or any clinical complications.

Results showed that when a combination of PRF and β-TCP was used for bone defects, the area of the new bone formed was significantly greater than in the group treated with these materials alone. In addition, radiographically findings showed that the quantity of the new bone formation was different in each group. This suggests that the efficiency of β-TCP can be improved by the addition of PRF.[14] Lee et al.[15] compared autogenous grafts with autogenous grafts plus PRF for sinus lifting operations. In the histomorphometric examination, the amount of the bone in autogenous graft /PRF combination group was more than in the group treated with autogenous bone grafts alone. Other study in agreement with our results as showed by Yilmaz et al[10] who stated that, when the PRF/β-TCP combination group was compared with the others, more new bone formation, including osteoblasts and osteocytes in the connective tissue, was observed. It is thought that PRF accelerates the healing effect by keeping the particles of β-TCP together via its adhesive property and adapting them tightly to the walls of the cavity. PRF increases the transformation of β-TCP particles into bone. PRF can be applied in bone defects alone or in combination with other materials. Kökdere *et al.*[16] studied PRP, β– TCP and fibrin adhesive in rabbits and they concluded that the use of PRf with synthetic graft materials is successful. Tang *et al.*[12] concluded from their study that the combined use of PRP with graft materials in bone defects contributes to wound healing.

In addition when defect areas filled with β–TCP were compared with the defects unfilled or filled with PRF alone, it was seen that β–TCP group was statistically significant in bone height, width and density more than group that filled with PRF alone. [95] Other study in agreement with our results as showed by Tang et al who noted that the new bone formation was more with the β–TCP than group that filled with PRF alone. it is reported that PRF dissolves more slowly than other platelet concentrates, it does not exceed months when the clinical samples only can be collected.[95]

CONCLUSION

The use of Beta-TCP with PRF was effective in socket preservation, reduces the need for future ridge augmentation to obtain optimal, functional, and esthetic results.

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