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APPLICATION OF PLATELET-RICH FIBRIN WITH B-TRICALCIUM PHOSPHATE FOR RECONSTRUCTION OF BONE IN PERIAPICAL DEFECTS

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ABSTRACT

Objective: This study was carried out to evaluate and compare the effect of PRF, β-TCP, and combination of these materials as periapical bone defect filling materials on the resulted bone density, cavity height, and cavity width by using cone beams computed tomography (CBCT) imaging. **Patients and methods:** This study was conducted on twenty-four patients with critical periapical bone defect about 2.5 cm in dimension in anterior region of maxilla resulting from periapical lesion, The patients were divided equally into three groups: Group A: the defect was filled with PRF alone. Group B: the defect was filled with β-TCP alone. Group C: the defect was filled with combination of PRF/ β-TCP. **Results:** The results of this study revealed that significant increase in bone density, as well as significant decrease in bony defect width and height in the three different studied groups after six months when compared to the baseline. **Conclusion:** The treatment of the periapical bone defects with different bone graft materials helps to increase the bone density and reduce the bone defect dimensions. The adjuvant uses of combination of PRF/ β-TCP in the treatment of preapical bone defect may contribute to more favorable and predictable bone formation at the grafted site.

KEYWORDS: Platelet-rich fibrin, β-tricalcium phosphate, Reconstruction, Periapical bone defect.

INTRODUCTION

Bone defect due to periapical lesion is of a surgical importance in the field of the maxillofacial surgery because of higher regional susceptibility to cyst, tumor, trauma, and/or fracture [1,2]. The periapical surgery to removes this periapical lesion in combination with the use of various graft material to enhances new bone formation at the defective site is of prime clinical importance [3].

The ultimate goal of periapical surgery is the complete wound healing through the predictable regeneration of periapical tissues, including the complete repair of the osseous defects [4]. Since natural healing takes a relatively long period of time for the bone to fill the residual cavity, regenerative methods that help restore missing tissue and speed up regeneration have been announced [5].

The clinical studies supported the grafting of critical size bony defects after enucleation of periapical lesions with regenerative bone graft materials [6-8]. The use of autogenous bone grafts and alloplastic grafts was the recommended bone grafting materials that could help with healing

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of bony defects as well as it reducing the risk of possible fractures of the jaws and shorten the recovery period[9].

Sahib et al., [5] demonstrated in their study that the bone density had showed a significantly increase after four monthes when they used PRF as cavity filling material when it compared with the other cavities heal spontaneously without grafting. This in agreement with Yilmaz et al., [10] who reported that the filling of bone defect with β–TCP were resulted in more new bone formation when compared to unfilled bone defects.

Calcium phosphate cement is bioactive cement and forms hydroxyapatite when moistened [11]. This material has been widely used in periapical surgery to enhance new bone formation [12]. In vivo studies; calcium phosphate did not show any inflammatory response and allows new bone formation as well as it forms osteoconductive apatite that has chemical and physical characteristics similar to bone, and is then replaced by natural bone [11, 13].

PRF is an autologous graft of platelets on a fibrin mesh that easy to obtain and is inexpensive[11]. It contains cytokines, leukocytes, and growth factors such as platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-beta), vascular endothelial growth factor (VEGF) [14]. Fibrin serves as a scaffold for cell migration and platelet entrapment, as well as, it has slow polymerization which leads to favorable healing[11,15]. PRF acts as better space filler and has advantages over bone grafting materials as autologous, indispensable in tissue wound healing [16].

However, it was found that the combined use of both PRF and β-TCP accelerate healing processes by the synergic effect of the inherent regenerative potential of PRF and the osteoconductive property of β-TCP [17]. This in accordance with the results of the previous clinical studies which concluded that the use of a combination of bioceramic material with PRF as bone graft produced significantly faster bone regeneration results compared to bioceramic bone graft alone [18].

Therefore, the purpose of this study was to evaluate and compare the effect of PRF and β-TCP alone or in combination on the bone density, and the dimension of the periapical bone defect. The hypothesis was that the combined use of PRF and β-TCP has a significant effect on the bone density and the dimension of the periapical bone defect.

SUBJECTS AND METHODS

This study was conducted on twenty-four patients with bone defect in anterior region of maxilla resulting from periapical lesion. Patients were selected from that attending outpatient clinic of Al-Azhar University, Cairo (boys) and Sayed Jalal University Hospital.

All patients were divided randomly into three equal groups (n=8) according to the cavity filling material as the follow:

- **Group A:** The defect was filled with combination of PRF/ β-TCP.
- **Group B:** The defect was filled with PRF alone.
- **Group C:** The defect was filled with β-TCP alone.

Patient Selection:

Selection of patients were based on specific inclusion and exclusion criteria as the follow:

A. Inclusion Criteria:

Patient who suffering from periapical lesions in anterior region of maxilla and resulting critical periapical bone defect about 2.5 cm in dimension, patient aged 18 to 40 years old and a willingness to cooperate with the study protocol and follow-up program.

B. Exclusion Criteria:

Uncontrolled systemic disease which could affect the bone healing, the patient who is treated with

radiotherapy for head and neck area and unwillingness to return for the follow-up examinations.

Ethical Consideration and Patient Consent:

This study was carried out after approval of ethical committee, Faculty of Dental Medicine, Al-Azhar University, Cairo, Boys, approval number 12201885.

Each patient was signed an informed consent having details about the whole surgical procedure before starting of the study. After getting informed consent from the patient, the treatment was done.

Preoperative Preparation:

Prior to surgery, a complete medical, dental and drug history as well as patient's data (name, gender and age) were collected. Then, the preapical lesion was imaged and assessed by CBCT imaging (Planmeca, Proface, Finland). An ideal root canal treatment was done. All patients were advised to do full mouth scaling and root planning of the involved tooth. Then, each patient was appointed for surgery[8].

Platelet Rich Fibrin (PRF) Preparation:

The protocol for PRF preparation is single stage centrifugation which performed in the absence of bovine thrombin (anti-coagulant). Blood specimen was collected or drawn from the patient just prior to surgery by taken 10 ml intravenous blood into a syringe and collected in a sterile glass test tube (10 ml) without anti-coagulant. The collected blood specimen was placed in the centrifuge and was allowed to spin immediately in centrifugation machine (LC-04R electric centrifuge. Wincom CO. China) for 10 min at 3,000 revolutions per minute (rpm). Following this the blood sample settles into various three layers because of differential densities of the formed layers. The middle portion containing the fibrin clot was then picked up with forceps and was scrapped off from the lower part containing the red blood cells. Then, the resulted PRF will be transferred into a sterile dish until use [8,19]

Surgical Procedures:

Using a standardized surgical protocol, all patients were treated under local anesthesia by using mepivacaine 2% with 1:20,000 Levonordefrin (Mepacaine-L, Alexandria Pharmaceutical Co., Egypt). Then, a full thickness mucoperiosteal flap with sharp blade was carried out and carefully reflected. A careful removal of the bone covering the lesion was made for creating a window on buccal bone around the root apex of affected tooth with periapical defect by using small round bur under copious irrigation of saline. Then, the apical third of affected root was removed. After complete removal of the preapical lesion and curettage, irrigation with saline was done. The root apex was closed by good apical seal mineral trioxide aggregate (MTA) material (Matreva dental lab co, Egypt) [8]. The enucleated cystic lining was placed in 10% formalin solution and sent for histopathological investigation.

Then, each cavity in each studied group was filled with the different tested bioactive filling materials until it completely filled the cavity up to the surrounding bone level. Finally, the mucoperiosteal flap was repositioned and sutured in place with simple interrupted sutures given using 3/0 non-absorbable silk suture. After surgery; written information about the post-operative instructions and the necessary follow-up care was provided to the patient. Suture was removed after 1 week later[8], **(Figure 1)**.

Postoperative Assessment:

All patients were examined the day after surgery, then 1st week after surgery, then on the end of 1st month after surgery for the presence/absence of pain/discomfort via visual analogue scale (VAS), swelling/edema, soft tissue healing, signs of infection, and wound exposure/dehiscence. Histopathological analysis was used to confirming the presence of periapical cystic lesion.

CBCT scanning was performed the day after surgery and after six months to measure the bone density, the bone defect height, and bone defect width.

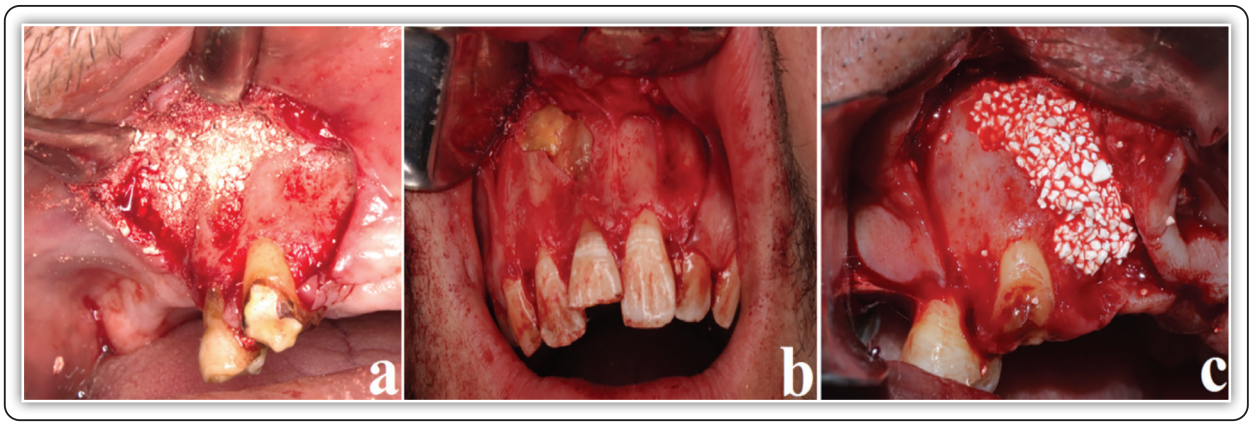

FIG (1) A clinical photograph showing the bioactive filling materials were placed in the bone defect area, in group A; the bony defect cavity was filled with PRF & β-TCP, in group B; the bony defect cavity was filled with PRF alone, While, in group C; the bony defect cavity was filled with β-TCP alone.

Statistical Analysis:

Data were collected, tabulated, and statistically analyzed using SPSS® Statistics Version 25 for Windows to detect whether significant differences existed between the means of the various studied groups.

RESULTS

Intraoperative and postoperative complications:

Minimal amount of bleeding was noticed intra and postoperatively. Proper wound healing was noticed without wound dehiscence in the three studied groups. Postoperative pain and swelling were manageable. Postoperative infection was absent. No perforation of the maxillary sinus membrane nor injury to the nasal cavity were detected in the upper jaw. No alveolar nerve injury was detected in the lower jaw.

Pain and swelling scores:

For both scores, there was no statistically significant difference between the three studied groups either in the base-line or after the 1st weeks from the surgery.

Bone density:

The statistical analysis of postoperative bone density of all studied groups after the 6th months of follow-up revealed that; the difference between all studied groups was statistically significant as indicated by One-way ANOVA test. The PRF/β-TCP treated group showed the highest bone density values with percentage of 57.34% from the base-line, followed by the β-TCP treated group with percentage of 42.68 %. While, the lowest bone density values from the base-line were recorded with PRF treated group with percentage of 40.32% **(Table 1)**.

Table (1): Comparison between bone densities after 6 months in all studied groups.

Bone density	PRF group	β-TCP group	PRF/β-TCP group	p-value
	Mean ± SD	Mean ± SD	Mean ± SD	
After 6th month	40.32±0.089	42.68 ±0.222	57.34±0.072	< 0.00001*

**; significant ($p < 0.05$).*

Bone Height:

The statistical analysis of postoperative bone height of all studied groups after the 6th months of follow-up revealed that the difference between all studied groups was statistically significant as indicated by One-way ANOVA test. The PRF/β-TCP treated group showed the highest reduction in bone height values with percentage of 51.23% from the base-line, followed by the β-TCP treated group with percentage of 45.17%. While, the lowest reduction bone height values from the base-line were recorded with PRF treated group with percentage of 36.03% **(Table 2)**.

Bone Width:

The statistical analysis of postoperative bone width of all studied groups after the 6th months of follow-up revealed that; the difference between all studied groups was statistically significant as indicated by One-way ANOVA test. The PRF/β-TCP treated group showed the highest reduction in bone width with percentage of 33.34% from the base-line, followed by the β-TCP treated group with percentage of 32.32%. While, the lowest reduction in bone width values from the base-line were recorded with PRF treated group with percentage of 30.03% **(Table 3)**.

TABLE (2) Comparison between bone heights after 6 months in all studied groups.

Bone Height	PRF group	β-TCP group	PRF/β-TCP group	p-value
	Mean ± SD	Mean ± SD	Mean ± SD	
After 6th month	36.03±0.015	45.17±0.026	51.23±0.011	< 0.00001*

**; significant (p < 0.05).*

Table (3): Comparison between bone widths after 6 months in all studied groups.

Bone Width	**PRF group**	**β-TCP group**	**PRF and β-TCP group**	***p*-value**
	Mean ± SD	Mean ± SD	Mean ± SD	
After 6th month	30.03± 0.042	32.32±0.071	33.34±0.081	<0.00001*

**; significant (p < 0.05).*

DISCUSSION

In the present study was conducted on twenty-four patients with bone defect resulting from periapical lesion. A twenty-four patients were divided randomly into three equal groups according to the cavity filling material, we used the Platelet-rich fibrin (PRF), β-tricalcium phosphate (β-TCP) and combination of both as bone grafts for treatment of periapical bone defects.

Many studies supported the grafting of critical size bony defects after enucleation of periapical lesions[1-5]. The use of different bone grafts include autogenous and alloplastic bone grafts were recommended as bone grafting materials that could help with healing of the periapical bone defects and reducing the risk of possible fractures of the jaws and shorten the recovery period [9].

In the present study the results showed that some patients complained of pain and swelling few days postoperatively after the surgical procedure and had no clinical significance on either pain or swelling scores. These findings are in concurrence with study done by Christiansen et al., [20], they used of different studied bone graft materials and had no clinical effect regarding pain and swelling. Also this was in acceptance with Singh et al., [21], who had evaluate pain and swelling between grafted and non-grafted side after bilateral mandibular impaction surgeries. They found that addition of the bone graft had no clinical significance on either pain or swelling scores.

This study proposed a method that permitted the detection of the progression of subtle changes in mineral bone gain that would be detectable in re-modeling bone repair process. These slight changes, could hardly be detected in visual analysis[22]. However, these changes could be identified and quantitatively measured by means of pixel grey values using CBCT [23]. Therefore, in this study it was possible to detect subtle changes in bone density at the periapical region using quantitative pixel measurement in CBCT images.

According to the results of this study, the group that treated with β-TCP alone showed higher increase in density than that treated with PRF alone. This could explain by the relative lack of mechanical strength and fast rate of absorption of PRF [24]. While, β-TCP has a low degradation rate and takes a longer period to be replaced by new bone tissue [17].

However, the finding of the present study revealed that the combined use of PRF/β-TCP showed significant increase of bone density when compared to PRF and β-TCP alone. This may be because of the fact that the addition of PRF to β-TCP increases its transformation into bony tissue, reduce the time required to promote graft consolidation, maturation, and improve the density of trabecular bone [17]. Additionally, in this mixture, the presence of autogenous graft triggers the release of osteoblasts and growth factors, while the β-TCP particles promoted the volume and architecture maintenance, due to their slow reabsorption [25].

The bony defect height was measured as the distance from the most apical aspect of the buccal bone defect to the coronal aspect of the buccal bony defect and the defect width was measured as the widest mesio-distal dimension of the buccal bony defect [26]. The decrease in the vertical "height" and horizontal "width" dimensions of the boney defect in the present study with use of PRF and β-TCP alone or in combination as cavity filling materials, resulted due to the formation of new bone. This may be because of, TCP provides a higher amount of calcium and phosphate that necessary for new bone formation [27]. Also, PRF acts as a source of growth factors thereby enhancing the healing process [24,26].

Valladão et al., [25] reported that the mixture of PRF autogenous graft and bioactive material is effective for vertical and horizontal bone healing, and permitting sufficient bone gain. In this combination the PRF were included in the treatment once they could increase the biological potential of the β-TCP by increasing the concentration of growth factors. While, β-TCP support revascularization and regeneration of hard and soft tissues due to its porous structure [28,29]. This can explain the results of this study were the combined use of PRF/ β-TCP resulted in the marked reduction in defect height and width.

CONCLUSION

The treatment of the periapical bone defects with PRF and β-TCP graft materials could markedly help to improve the bone density and reduce the bone defect dimensions. Moreover, the combined use of PRF/ β-TCP in the treatment of preapical bone defect may contribute to more favorable and predictable bone formation at the grafted site.

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