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EFFECT OF USING TRI-CALCIUM PHOSPHATE COMBINED WITH PLATELET RICH FIBRIN VERSUS PLATELET RICH PLASMA IN POST EXTRACTION SOCKET

Mohamed Abed Abou Shabana [1*], Mohamed Abdelalkher Mohamed [2], Ahmed Ahmed Hussin El-Feky [3]

ABSTRACT

Objectives: This study was designed to evaluate the effect of using tricalcium phosphate combined with platelet rich fibrin versus platelet rich plasma in post extraction socket clinically and radiographically at maxillary esthetic zone. **Subject and methods:** This study was conducted on 30 patient seeking extraction of at least one hopeless tooth, they distributed into 3 groups.10 patients for control group , 10 patients for test group (a) and 10 patients for test group (b). In control group the socket was left to heal spontaneously by clot formation. In test group (a) the socket was filled with beta-tricalcium phosphate as bone graft and platelet rich fibrin. In test group (b) the socket was filled with beta-tricalcium phosphate and platelet rich plasma. CBCT image was taken to compare the vertical, horizontal ridge dimension and bone density pre-operatively and 6 month post-operatively. **Result:** There was statistically non-significant difference regarding the vertical height, bone width, buccal plate thickness and bone density in both groups pre-operatively. But after 6 months post-operatively there was statistically significant difference regarding three groups in all parameters. The test group (a) that represented βTCP and PRF showed a lower percentage of a change than test group (b) that represented βTCP and PRR than control group. **Conclusion:** The use of PRF accelerates socket wound healing after tooth extraction as noticed by reducing vertical and horizontal bone loss and maintaining favorable bone density values after 6 months postoperatively.

KEY WORDS: PRF, PRP, socket preservation, tricalcium phosphate.

INTRODUCTION

Patients present for tooth extraction for various reasons e.g. (caries, periodontal disease)[1]. The dental literature describes loss of bone volume after dental extractions of up to 50% within 6 months[2-4]. The effect of bone loss is magnified when multiple teeth are extracted in the same area[5]. Socket collapse can prevent or significantly inhibit the placement of dental implants in ideal, prosthetically driven positions [6]. Severe loss of alveolar volume may necessitate ridge augmentation by block grafting and other extensive surgical procedures if dental implants are to be placed for the support of a prosthesis [7].

Clinical studies have shown that implants placed in a site with a missing buccal bone wall have a

1. Masters Candidate, Mansoura University
2. Professor, Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University
3. Associate Professor, Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University

• ***Corresponding author*:** mohamed.abed1890@gmail.com

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greater rate of soft tissue complications and/or compromised long term prognosis [8-12]. In these circumstances, fibrous tissue will likely to occupy part of the socket, preventing normal healing and osseous regeneration [13]. Hence, preservation of alveolar dimensions after tooth extraction is crucial to maintain adequate bone volume for placement and stabilization of the implants and to achieve optimal esthetic and functional prosthetic results.

The Bone grafting is the best way to rebuild a correct bone anatomy which would be able to receive a dental implant. The graft is defined by placing tissue on a patient, taken from the same patient (autograft), from another patient but from the same race (human-to-human: allograft), from another race (animal to human: Xenografts), or synthetic bone graft (alloplastic or biomaterials or bone substitutes) [14]. Although freshly harvested, autogenous cancellous marrow has always been the most biologically viable material; however, its clinical use is limited. This is due to the need for a second operation or surgical site and the potential complications arising from this and greater time of surgery and anesthesia [15] .

There are a large number of biological and synthetic substitute bone materials, which do not differ significantly in their clinical application and can be easily, cost-effectively and efficiently used with minimum extra expense. Materials like TCP are osteoconductive because osteoblasts adhere to them and deposit bony tissue on their surface. The biomaterial forms a scaffold for closing the bony defect [16]. Recently, the use of platelet concentrate in combination with graft materials is increasingly recommended. Platelet is known to contain high quantities of growth factors, such as transforming growth factors ß-1 (TGFß-1), platelet-derived growth factor (PDGF), epithelial growth factor (EGF), insulin growth factor-I (IFG-I) and vascular endothelial growth factors (VEGF), which stimulates cell proliferation and up regulates angiogenesis [17] .

This concept of fabricating growth factors enriched bone graft matrix, also known as “sticky bone” or mineralized plasmatic matrix (MPM), using autologous fibrin glue has been demonstrated. This sticky bone provides stabilization of bone graft in the defect, entraps platelets and leukocytes in its fibrin network, and therefore, accelerates tissue healing and minimizes bone loss during healing period and prevents in growth of soft tissues in graft [18]. Cone beam computed tomography (CBCT) provides a three-dimensional image of the dental and maxillofacial areas, useful tool for evaluation of alveolar ridge sites and can be used to locate anatomical structures, support diagnostic implant planning, and function as a guide for dental surgery. Reliable linear measurements of dento-maxillofacial structures and volume estimates can be produced from this type of imaging, thereby indicating that the CBCT may have the potential to evaluate socket preservation healing [19, 20].

Therefore, the current study was an attempt to compare the effects of using tri-calcium phosphate as a graft material combined with platelet rich fibrin versus tri-calcium phosphate with platelet rich plasma in post extraction socket, clinically and radiographically.

SUBJECT AND METHODS

Thirty patients were participated in this study and they selected from the outpatient clinic, Department of Oral and Maxillofacial surgery, Faculty of Dental Medicine, Al Azhar University, Cairo, Boys. Nineteen male patients and eleven female patients participated in this study. The age ranged from 17-40 years.

I- Inclusion criteria:

Patients were selected according to the following criteria:

Patients with a single rooted maxillary tooth that need extraction as; endodontic complication, root fracture, or trauma and intact labial plate of bone at the extraction site.

II- Exclusion criteria:

Patients having debilitating uncontrolled systemic diseases, presence of acute infection and heavy smokers.

The patients were divided randomly according to filling material into three groups:

Group A (control): Comprised ten patients 6 males and 4 females. The mean age of the patients in the control group was 31.7 years. Extraction socket was left for normal healing (blood clot), just patient presses on the gauze for promoting hemostasis.

Group B (study): Included ten patients 8 males and 2 females, and the mean age of the study group was 32.2 years. Extraction socket was filled with combination of tricalcium phosphate and platelet rich fibrin.

Group C (study): Included ten patients 5 males and 5 females, and the mean age of the study group was 35.5 years. Extraction socket was filled with combination of tricalcium phosphate and platelet rich plasma.

Surgical Procedures:-

Extractions were done using periotomes and extraction forceps, without raising a mucoperiosteal flap with care to preserve the labial bone plate and the surrounding soft tissues.

Preparation of PRF:-

10 ml Blood was collected, from the patient after extraction in the clinic by a sterile plastic syringe. The dried glass tube without anticoagulant were centrifuged at 2700 rpm for 12 minutes at room temperature in the laboratory centrifuge. After centrifugation, three layers are formed: the RBC base layer, a cellular plasma top layer and a PRF clot in the middle.

The PRF clot forms a strong fibrin matrix with a complex three dimensional architecture, in which and leucocytes from the harvested blood are concentrated. The product is pressed between two gauzes, so the PRF clot becomes a strong membrane, and some applications of this autologous biomaterial have been described in oral and maxillofacial surgery. The PRF clot become ready to be loaded in the socket after mixing with bone graft.

Preparation of PRP:-

10 ml Blood was collected, from the patient after extraction by a sterile plastic syringe using dried plastic tube with anticoagulant. There is a first centrifugation (900 rpm/5 minutes) to separate the red cells from the white cells, and three layers are obtained a superior one rich in platelet and white cells, a medium one of buffy coat that is rich in WBCs, and an inferior layer with the red cells.

For the production of pure PRP (P-PRP), upper layer and superficial buffy coat are transferred to an empty sterile tube. For the production of leucocyte rich PRP (L-PRP), the entire layer of buffy coat and few RBCs are transferred to an empty sterile tube. After collecting the two superior layers, a second centrifugation at 1500 rpm/15 minutes excludes the red cells.

The upper portion of the volume that is composed mostly of PPP (platelet-poor plasma) is removed. Pellets are homogenized in lower third (5ml of plasma) to create the PRP (Platelet-Rich Plasma).

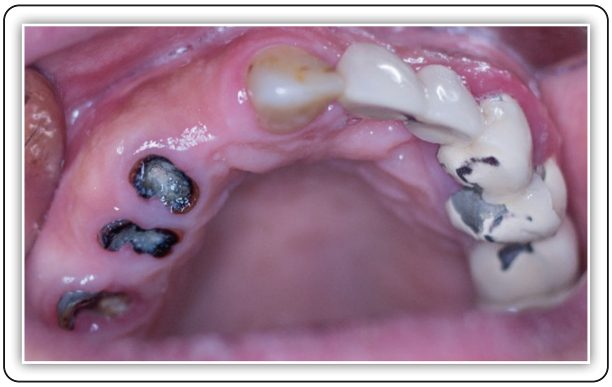

FIG (1) The case before extraction.

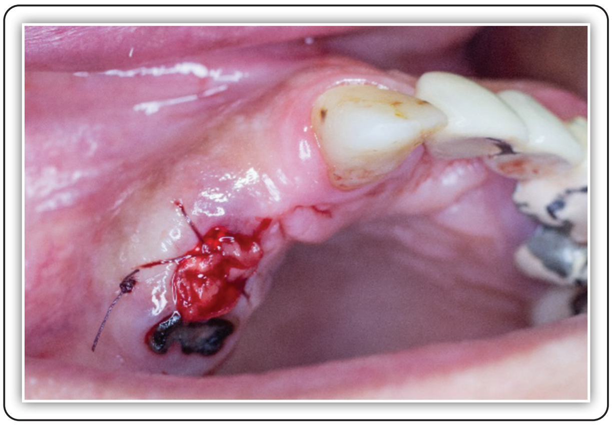

FIG (2) PRF membrane covering the graft and secured with sutures.

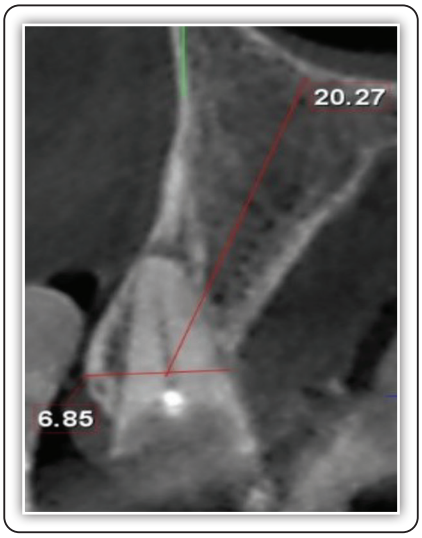

FIG (3) Pre-operative CBCT showing height and width.

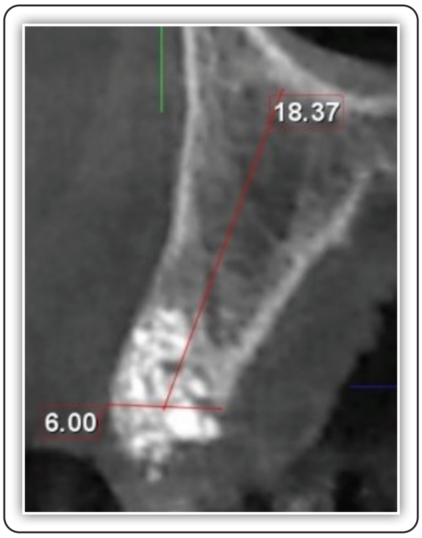

FIG (4) Six months post-operative CBCT showing height and width.

Statistical analysis of the data:

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0

RESULTS

I. Demographic data

Ten patients ranged in age between 33.0 – 35.0 years with a mean age of 34.20 ± 1.03 years for control group, ten patients ranged in age between 33.0 – 40.0 years with a mean age of 36.30 ± 2.63 years for βTP+PRF group, and ten patients ranged in age between 34.0 – 38.0 years with a mean age 36.0 ± 2.11 years for βTP+PRP group. There was statistically non-significant difference between the groups regarding to the mean of age. Control group had 4 males and 6 females, βTP+PRF group had 5 males and 5 females, while βTP+PRP group had 6 males and 4 females. There was statistically non-significant difference between gender distributions in the groups (Table 1).

II. Vertical bone height.

Table (2) Summarizes comparison between the three studied groups according to vertical bone height. Preoperative, there was a statistically non-significant difference in mean vertical bone height in the three groups. At 6 months, there was a statistically significant difference in mean vertical bone height in the three groups. βTP+PRF group showed a higher vertical bone height than βTP+PRP group than control group. Regarding percent of change 6 M from preoperative, there was a statistically a significant difference in mean vertical bone height in the three groups. βTP+PRF and βTP+PRP groups showed a lower percent of change of vertical bone height than control group.

TABLE (1) Comparison between the three studied groups according to demographic data.

	Control (n = 10)	BTP/PRF (n = 10)	BTP/PRP (n = 10)	Test of Sig.	p
Sex					
Male	6 (60.0%)	5 (50.0%)	6 (60.0%)	χ^2= 0.381	^{MC}p= 1.000
Female	4 (40.0%)	5 (50.0%)	4 (40.0%)		
Age (years)					
Min.–Max.	33.0 – 35.0	33.0 – 40.0	34.0 – 38.0	F= 3.118	0.060
Mean ± SD.	34.20 ± 1.03	36.30± 2.63	36.0 ± 2.11		
Median	35.0	35.0	36.0		

χ2: Chi square test *MC: Monte Carlo* *F: F for ANOVA test*

p: p value for comparing between the studied groups

TABLE (2) Comparison between the three studied groups according to vertical height.

Vertical bone height	Control (n = 10)	BTP/PRF (n = 10)	BTP/PRP (n = 10)	p
Preoperative	**19.57 ± 1.31**	19.24 ± 1.57	19.05 ± 1.59	^{F}p=0.738
6 Month	**16.30 ± 2.98**	18.21 ± 1.28	18.19 ± 0.84	^{F}p=0.056
% of change 6 M from Preoperative	**16.85 ± 13.03**	5.29 ± 1.13	4.17 ± 5.08	^{H}p=0.001*
Sig. bet. grps.	**p_1<0.001*,p_2=0.008*,p_3=0.034***			

F: F for ANOVA test

H: H for Kruskal Wallis test, Pairwise comparison bet. each 2 groups were done using Post Hoc Test (Dunn's for multiple comparisons test)

p: p value for comparing between the studied groups

p_1: p value for association between Control and BTP/PRF

p_2: p value for association between Control and BTP/PRP

p_3: p value for association between BTP/PRF and BTP/PRP

**: Statistically significant at p ≤ 0.05*

III. Alveolar bone width.

Table (3) Summarizes comparison between the three studied groups according to alveolar bone width. Preoperative, there was a statistically non-significant difference in mean alveolar bone width in the three groups. At 6 months, there was a statistically a significant difference in mean alveolar bone width in the three groups. βTP+PRF group showed a higher alveolar bone width than βTP+PRP group than control group. Regarding percentage of change 6 M from preoperative, there was a statistically a significant difference in mean alveolar bone width in the three groups. βTP+PRF group showed a lower percentage of change of alveolar bone width than βTP+PRP group than control group.

TABLE (3) Comparison between the three studied groups according to alveolar bone width.

Alveolar bone width	Control (n = 10)	BTP/PRF (n = 10)	BTP/PRP (n = 10)	p
Preoperative	**7.49 ± 1.32**	7.25 ± 0.69	7.92 ± 1.55	**^{F}p=0.481**
6 Month	3.54 ± 0.47	6.44 ± 0.81	5.77 ± 0.61	^{F}p<0.001*
Sig. bet. grps.	p_1<0.001*,p_2<0.001*,p_3=0.072			
% of change 6 M from Preoperative	**51.82 ± 7.74**	11.45 ± 2.95	25.62 ± 10.07	**^{H}p<0.001***
Sig. bet. grps.	**p_1<0.001*,p_2=0.008*,p_3=0.034***			

F: F for ANOVA test, Pairwise comparison bet. each 2 groups was done using Post Hoc Test (Tukey)

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

p1: p value for association between Control and BTP/PRF

p2: p value for association between Control and BTP/PRP

p3: p value for association between BTP/PRF and BTP/PRP

**: Statistically significant at p ≤ 0.05*

IV. Bone density.

Table (4) Summarizes comparison between the three studied groups according to bone density. Preoperative, there was a statistically non-significant difference in mean bone density in the three groups. At 6 months, there was a statistically a significant difference in mean bone density in the three groups. βTP+PRF group showed a higher bone density than βTP+PRP group than control group. Regarding percentage of change 6 M from preoperative, there was a statistically a significant difference in mean bone density in the three groups. βTP+PRF group showed a lower percentage of change of bone density than βTP+PRP group than control group.

TABLE (4) Comparison between the three studied groups according to bone density.

Bone density	Control (n = 10)	BTP/PRF (n = 10)	BTP/PRP (n = 10)	p
Preoperative	506.0 ± 89.96	550.0 ± 48.99	534.0 ± 52.54	^{F}p=0.340
6 Month	265.0 ± 83.57	497.0 ± 44.98	464.0 ± 49.26	^{F}p<0.001*
Sig. bet. grps.	p_1<0.001*,p_2<0.001*,p_3=0.466			
% of change 6 M from Preoperative	47.66 ± 12.35	9.65 ± 0.50	13.17 ± 1.52	^{H}p<0.001*
Sig. bet. grps.	p_1<0.001*,p_2=0.011*,p_3=0.011*			

F: F for ANOVA test, Pairwise comparison bet. each 2 groups was done using Post Hoc Test (Tukey)

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

p1: p value for association between Control and BTP/PRF

p2: p value for association between Control and BTP/PRP

p3: p value for association between BTP/PRF and BTP/PRP

**: Statistically significant at p ≤ 0.05*

DISCUSSION

The participant baseline characteristics such as age and gender distribution did not affect the outcome of the study, as the baseline characteristics were equally distributed between the groups and showed no statistically significant findings. At 1 month, there was a statistically non-significant difference in dehiscence in which all groups showed no dehiscence. At 2 weeks and 1 month, there was a statistically non-significant difference in mean pain in the three groups.

In the present study, all groups showed a statistically significant decrease in mean bone density measurements at 6 month. At 6 months, there was a statistically a significant difference in mean bone density in the three groups. βTP +PRF group showed a higher bone density than βTP +PRP group than control group. Regarding percentage of change 6 M from preoperative, there was a statistically significant difference in mean bone density in the three groups. βTP +PRF group showed a lower percentage of change of bone density than βTP+PRP group than control group. The results of the current study indicated that there was high bone density formed in the socket of PRF and PRP groups as compared to the control after 6 month by CBCT because the maximum density was significantly higher in the PRF group (497.0 ± 44.98) and PRP group (464.0 ± 49.26) compared to control (265.0 ± 83.57), this lead to biological effect of PRF as sole graft.

This agreed with the results obtained in previous studies conducted by Shrivastava et al. (21) that state on there was early osseous bone regeneration in the PRF groups at a given points of time in mandibular as well as in maxillary in both sexes (22). Many clinical studies suggest that the mixture the growth factors contained PRF and PRP with bone graft may be suitable to enhance bone density (23-25).

This also was in agreement to the results obtained in previous studies con ducted by Kamal et al. (26), examine the role of platelet rich fibrin in healing of extraction socket. Platelet Rich Fibrin show better healing effect and increase in bone density compared to standard of care. The biological properties of PRF contain several growth factors (BDGF, TGF-beta, EGF, VEGF, IGF-1, beta-FGF, and HGF) obtained with a simple centrifugation procedure, to stimulate several biological functions such as chemotaxis, angiogenesis, proliferation, differentiation, modulation, thereby presenting a possible therapeutic device for a more rapid and effective regeneration of hard and soft tissue (27).

Alzahrani et al. (28), evaluated clinically and radiographically, extraction socket healing using autologous platelet rich fibrin (PRF). The mean horizontal ridge width for sockets in the test group were 11.70 ± 2.37 mm, 11.33 ± 2.30 mm and 10.97 ± 2.33 mm at 1, 4 and 8 weeks respectively. Ridge width proportions were significantly higher among test group as compared to control group between baseline to 4 and 8 weeks respectively. The study outcomes demonstrate that the use of PRF accelerate socket wound healing after tooth extraction as noticed by increased bone fill and reduced alveolar bone width resorption using clinical and radiographic methods.

The alveolar bone height loss and the reduction of alveolar width with the radiographic bone fill was noted. Clinical studies have shown an average vertical bone resorption of 0.7 to 1.5 mm, as well as an average horizontal resorption of 4.0 to 4.5 mm after extraction in normal alveolar sockets (29). In this study all groups showed a statistically a significant decrease in mean vertical bone height measurements at 6 month. At 6 months, there was a statistically non-significant difference in mean vertical bone height in the three groups. Regarding percentage of change 6 M from preoperative, there was a statistically a significant difference in mean vertical bone height in the three groups. βTP+PRF and βTP+PRP groups showed a lower percentage of change of vertical bone height than control group.

CONCLUSION

This study's outcomes demonstrated that the use of PRF accelerates socket wound healing after tooth extraction as noticed by reduced alveolar bone width and height resorption and maintained a favorable bone density.

REFERENCES

1. Al-Shammari KF, Al-Ansari JM, Al-Melh MA, et al. Reasons for tooth extraction in Kuwait. Med Princ Pract. 2006;15 :417-422.
2. Schoop L, Wenzel A, Kostopoulos L, et al. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. Int J Periodontics Restorative Dent. 2003; 23:313-323.
3. Lam RV. Contour changes of the alveolar processes following extraction. J Prosthet Dent. 1960; 10:25-32.
4. Pietrokovski J, Starinsky R, Arensburg B, et al. Morphologic characteristics of bony edentulous jaws. J Prosthodont. 2007; 16:141-147.
5. Pietrokovski J. The bony residual ridge in man. J Prosthet Dent. 1975; 34:456-462.
6. Mecall RA, Rosenfeld AL. Influence of residual ridge resorption patterns on implant fixture placement and tooth position. 1. Int J Periodontics Restorative Dent. 1991; 11:8-23.
7. Nevins M, Camelo M, De Paoli S, et al. A study of the fate of the buccal wall of extraction sockets of teeth with prominent roots. Int J Periodontics Restorative Dent. 2006; 26:19-29.
8. Amler MH, Johnson PL, Salman I. Histological and histochemical investigation of human alveolar socket healing in undisturbed extraction wounds. J Am Dent Assoc .1960;61:32-44.
9. Araújo MG, Sukekava F, Wennström JL, et al. Tissue modeling following implant placement in fresh extraction sockets. Clin Oral Implants Res .2006;17:615-24.
10. Covani U, Bortolaia C, Barone A, et al. Buccolingual crestal bone changes after immediate and delayed implant placement. J Periodontol .2004;75:1605-12.
11. Tan WL, Wong TL, Wong MC, et al. A systematic review of post-extractional alveolar hard and soft tissue dimensional changes in humans. Clin Oral Implants Res .2012;23: 1-21.
12. Trombelli L, Farina R, Marzola A, et al. Modeling and remodeling of human extraction sockets. J Clin Periodontol .2008;35:630-39.
13. El Askary, AES. Socket Augmentation: Rationale and Technique, in Fundamentals of Esthetic Implant Dentistry. Blackwell Munksgaard, Oxford, UK.
14. Davarpanah M, Szmukler-moncler S, Khoury PM, et al. Manuel d'implantologie Clinique 2e edition. Édition CdP p60, Publisher: Cahiers de prothèses editions, Paris, France.
15. Horch HH, Sader R, Pautke C, et al. Synthetic, pure-phase beta-tricalcium phosphate ceramic granules (Cerasorb) for bone regeneration in the reconstructive surgery of the jaws. In J Oral Maxillofac Surg .2006;35:708-713.
16. Roesgen M. Knöcherne. Regeneration und Calcium phosphate keramiken. In: Weller S, Hierholzer G, eds.Traumatologie aktuell 4. Stuttgart: Thieme. 1997
17. Oncu E, Bayram B, Kantarci A, et al. Positive effect of platelet rich fibrin on osseointegration. Med Oral Patol Oral Cir Bucal. 2016; 21:601–7.
18. Dong-SeokSohn, Bingzhen Huang, Jin Kim, W. et al. Utilization of Autologous Concentrated Growth Factors (CGF) Enriched Bone Graft Matrix (Sticky Bone) and CGF-Enriched Fibrin Membrane in Implant Dentistry. The Journal of Implant & Advanced Clinical Dentistry. 2015; 7:11-28.
19. Agbaje J, Jacobs R, Maes F, et al. Volumetric analysis of extraction sockets using cone beam computed tomography: a pilot study on ex vivo jaw bone. J Clin Periodontol .2007; 34: 985-990.
20. Lascala C, Panella J, Marques M. Analysis of the accuracy of linear measurements obtained by cone beam computed tomography (CBCT-NewTom). Dentomaxillofac Radiol .2004; 33: 291-294.
21. Shrivastava A, Shenoi R, Garg A, et al. Role of Platelet Rich Fibrin in Healing of Extraction Socket. International Journal of Contemporary Medical Research. 2018; 5:6.
22. Simonpieri A, Del Corso M, et al. Current knowledge and perspectives for the use of platelet-rich plasma (PRP) and platelet-rich fibrin (PRF) in oral and maxillofacial surgery part 2: Bone graft, implant and reconstructive surgery. Curr Pharm Biotechnol .2012;13, 1231-1256.
23. Sanchez AR, Sheridan PJ, Kupp LI. Is platelet-rich plasma the perfect enhancement factor? A current review. The International journal of oral & maxillofacial implants. 2003;18:93-103

24. Simon BI, Zatcoff AL, Kong JJ, et al. Clinical and Histological Comparison of Extraction Socket Healing Following the Use of Autologous Platelet-Rich Fibrin Matrix (PRFM) to Ridge Preservation Procedures Employing Demineralized Freeze Dried Bone Allograft Material and Membrane. The open dentistry journal. 2009; 3:92-9.

25. Mazor Z, Horowitz RA, Del Corso M, et al. Sinus floor augmentation with simultaneous implant placement using Choukroun's platelet-rich fibrin as the sole grafting material: a radiologic and histologic study at 6 months. Journal of periodontology. 2009; 80:2056-64.

26. Kamal Saheb Mezal1, Sahar Shakir Al-Adili, Ali S. Al-Haddad. Evaluation of Platelet Rich Fibrin Effect in the Bone Density after Teeth Extraction by Cone Beam Computed Tomography. Indian Journal of Public Health Research & Development .2019; Vol.10, No.4:453-456.

27. Gruber R, Varga F, Fischer MB, et al. Platelets stimulate proliferation of bone cells: involvement of platelet-derived growth factor, microparticles and membranes. Clinical oral implants research. 2002; 13:529-35.

28. Alzahrani AA, Murriky A, Shafik S. Influence of platelet rich fibrin on post-extraction socket healing: A clinical and radiographic study. Saudi Dent J. 2017; 29:149-155.

29. Van der Weijden F, Dell' Acqua F, Slot DE. Alveolar bone dimensional changes of post-extraction sockets in humans: a systematic review. J Clin Periodontol. 2009; 36:1048-58.