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Research Article

Comparative Radiological Evaluation of Extraction Socket Preservation Techniques involving Xenograft (Cerabone™), Platelet Rich Fibrin (PRF) and its combination. A Randomised Control Trial.

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ABSTRACT:

Background and objectives: Extraction of a tooth leads to an inevitable loss of bone morphology which makes the placement of fixed partial denture or an implant difficult due to compromised esthetics and occlusion. Therefore, to limit the loss of morphological dimension various bone substitutes, blood concentrates, membranes and their combination have been used. The aim and objectives of this study are to assess and compare radiographically using digital evaluation method (Digimizer software) along with residual alveolar socket changes to assess bone fill percentage at various time intervals for a period of 6 months post extraction. **Materials and methods:** 48 patients between age group of 18 to 30 years with maxillary and mandibular premolars indicated for extraction were assigned to 4 groups i.e. Group I {Control group}, Group II {PRF}, Group III{Xenograft (Cerabone™)}, Group IV {Xenograft (Cerabone™) + (PRF)}. Bone fill percentage was recorded at various time intervals such as postoperative grafting, 6 weeks, 3 months and 6 months. **Results:** Although wide variation were observed with respect to bone fill percentage at various intervals immediately after the procedure and in early part of the study, the results more or less evened out by the end of 6 months post operatively. At 6 months mean Bone fill Percentage of group I, II, III and IV are 79.6%,79.6%, 82.7% and 86.2 respectively. **Conclusion:** Residual alveolar socket preservation post extraction limits the morphological changes of alveolar bone and helps to maintain the dimension of the alveolar ridge for future prosthetic rehabilitation.

KEYWORDS: *Extraction Socket Preservation, PRF, Cerabone™, Digimizer*

INTRODUCTION

Socket preservation is a procedure undertaken at the time of or following an extraction that is designed to minimize external resorption of the socket and maximize bone formation within the socket. Socket preservation is a technique wherein the amount of bone loss is minimized.[1] A tooth may be lost due to several reasons like caries, periodontal disease, trauma etc. Post tooth extraction, the alveolar ridge is known to decrease in volume and change morphologically. These changes to the socket can make the placement of a conventional fixed partial denture (FPD) or an implant difficult due to which esthetic and occlusion may get compromised.[2] If bone resorption is significant enough, then placement of an implant may become extremely challenging. Autogenous bone is still regarded as the gold standard for the repair of bony defects in the maxillofacial region.[3-5]Autogenous bone has osteoconductive, osteoinductive and osteogenic properties. The advantage of autogenous bone is that it maintains bone structures such as minerals and collagen, as well as viable osteoblasts and BMPs.[6] However, the quantity of bone is limited and there is additional morbidity, as harvesting autogenous bone requires a second surgical site.[7-8]For the preservation of alveolar socket, various bone grafting materials like autografts, allografts, xenografts and alloplasts have been used alone or in combination with resorbable and non resorbable membranes and blood concentrates like Platelet-rich fibrin (PRF).[9] The aim and objectives of this study are to measure and compare radiographically using digital evaluation method {Digimizer software (Version 4.6.1)} alongside residual alveolar socket changes to assess bone fill percentages at various time intervals for a period of 6 months post extraction following the use of Xenograft (Cerabone™), Platelet-rich fibrin (PRF) and a combination of Xenograft (Cerabone™) and PRF along with control group.

MATERIALS AND METHODS

Participants for the present study were the patients visiting the outpatient section of the Department of Periodontology, Krishnadevaraya College of Dental Sciences and Hospital, Bengaluru, India, were screened and randomly recruited for the study as per the inclusion and exclusion criteria.

The inclusion criteria are systemically healthy patients between age group of 18 to 30 years whose maxillary and mandibular premolars are indicated for extraction with adjacent tooth on either sides. The exclusion criteria are patients suffering from any systemic medical conditions, bone metabolic disorders, periapical pathology, medications known to alter bone metabolism or any malignancy. Local factors like acute infection at the site of extractionor ankylosed tooth. Patients who are smokers and alcoholics.

The patients were randomised into four experimental groups [Group I- Control group, Group II- Platelet-rich fibrin (PRF), Group III- Xenograft (Cerabone™), Group IV- Xenograft (Cerabone™) + Platelet-rich fibrin (PRF)] using sealed envelope technique. 48 small cards were made (12 of each group) and concealed in opaque envelopes. Once a patient had consented for treatment the envelope was opened and the patient was offered the allocated treatment regimen.

Pre-Treatment Records were obtained from each patient for the purpose of documentation, communication and treatment planning.Detailed medical and dental history, routine blood investigations and standardised intraoral radiographswas taken pre-operatively and immediately after extraction using Radiovisiography (RVG) to evaluate the status of the tooth and surrounding bone before extraction so that it can be later compared for evaluating the amount of bone fill.

Radiographical Parameters used in the study were superficial most part of the Alveolar Crest (AC) and base of the Socket (BS).

Radiographic Measurements followed were

- Area of the Extraction Socket - Area of extraction socket measured from Alveolar Crest till the base of the socket. Area of the extraction socket is is measured in mm^2.
- Bone Fill – The radiolucent area (bone formed) or the radiopaque area (graft placed) from to the base of the socket till the alveolar crest is measured in the Digimizer software. Area of bone fill is measured in mm2.
- Bone Fill % = $\frac{\text{Bone Fill}}{\text{Area of the Extracted Socket}} \times 100$

Surgical Protocol

Group I - Atraumatic extraction was performed under local anaesthesia (2% Lignocaine in 1:80000 Adrenaline) using periotomes. The blade of the periotome was placed in the periodontal ligament space of the tooth to be extracted in a walking motion to luxate the tooth. After sufficient mobility was achieved forceps was used to remove the tooth. Socket was curetted of soft tissue debris. The flaps were approximated and interrupted sutures were placed using 3-0 non-absorbable black braided silk suture {Lifeline, Bangalore, India}. (Figure 1)

Group II -10ml of whole venous blood was collected by venepuncture from the antecubital fossa in sterile vacutainer tubes without anticoagulant. The vacutainer tubes were then placed in a centrifugal machine {REMI CM-8 PLUS, REMI Elektrotechnik Ltd., Thane, Maharashtra, India} at 3000 rpm for 10 minutes.[10] PRF was obtained. Followed by extraction PRF thus obtained from the centrifuge, was taken out by a sterile tweezer from the test tube and placed in a bowl. PRF clot is separated from red corpuscle base with a scissor and placed into the socket and sutured. (Figure 2)

Group III- Atraumatic extraction was done. Socket was curetted of soft tissue debris. Xenograft (Cerabone™) {BIOTISS Dental GmbH, Berlin, Germany} was placed in a sterile bowl and mixed with saline. The cohesive mass thus obtained was carried by a graft carrier and placed in the socket and sutured. (Figure 3)

Group IV- PRF was obtained and atraumatic extraction was done. Socket was curetted of soft tissue debris. PRF thus obtained from the centrifuge was taken out by a sterile tweezer from the test tube and separated from red corpuscle base with a scissor and placed in a sterile bowl and mixed with Xenograft (Cerabone™) to achieve a sticky consistency. The cohesive mix of graft and PRF was carried with a graft carrier and placed in the socket and sutured. (Figure 4)

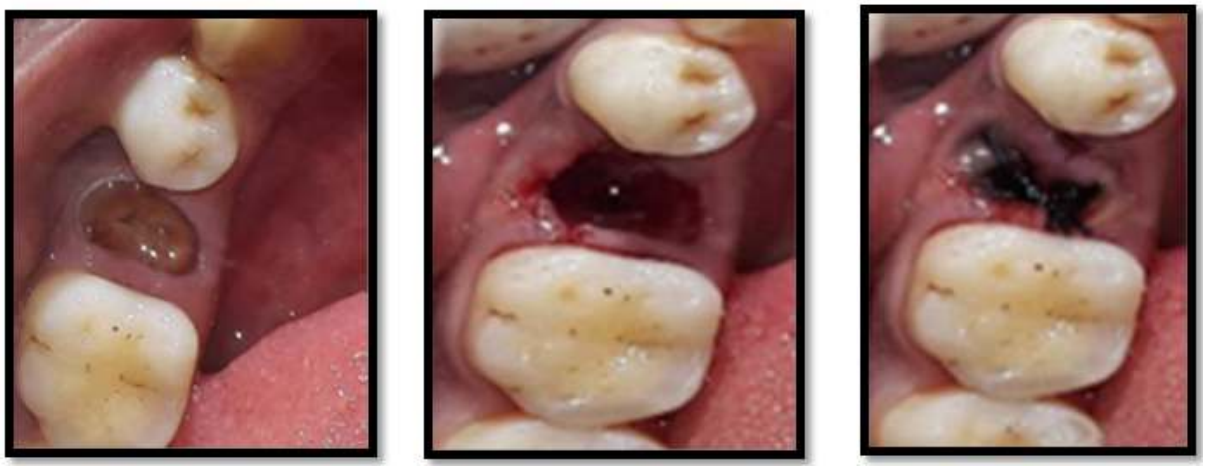
Followed by postsurgical procedure postoperative instructions were given. Post-operative pain was controlled with non-steroidalanti inflammatory drug,Ibuprufen 400mg, thrice daily, for three days. Only soft diet was advised for the first 2 weeks of the healing

process. Sutures were removed 7-10 days post surgery and the surgical site was evaluated for healing, infection and signs of inflammation.
Post-surgical evaluations of hard and soft tissues were done at 6 weeks, 3 months and 6 months post-surgery. At each recall visit radiographs were recorded.

RESULTS

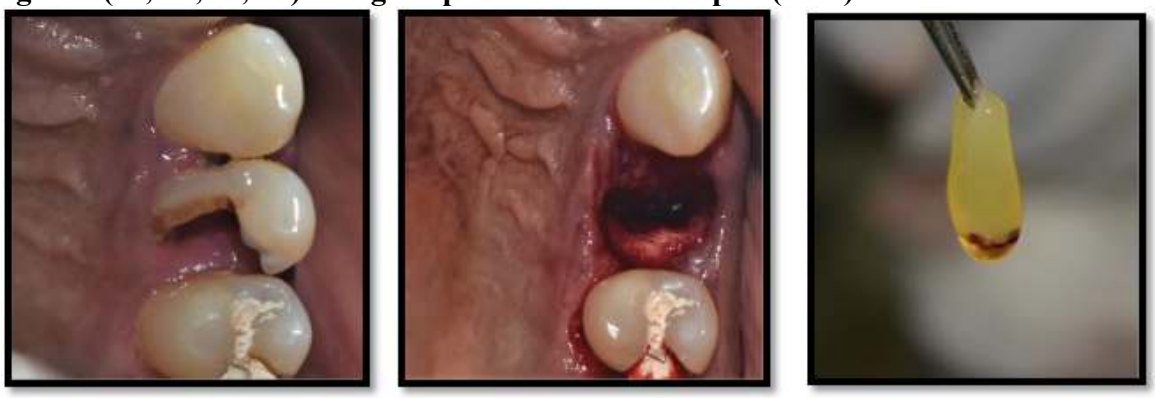
The present study was conducted was carried out to assess and compare bone fill percentage radiographically at various time intervals such as 6 weeks, 3 months and 6 month post extraction following the use of Xenograft (Cerabone™), Platelet-rich fibrin (PRF) and a combination of Xenograft (Cerabone™) and PRF along with control group. (Figure 5, 6, 7, 8)
Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS version 18.5). The results for each parameter (numbers and percentages) for discrete data and averaged (mean + standard deviation) for each parameter were presented in tables and figures. The null hypothesis for this test is that the data are normally distributed. The Prob< W value listed in the output is the p-value. If the chosen alpha level is 0.05 and the p-value is less than 0.05, then the null hypothesis that the data are normally distributed is rejected. If the p-value is greater than 0.05, then the null hypothesis has not been rejected. Parameter in the study normally distributed so comparison between the groups was carried out using parametric test was used.
One way analyses of variance(Anova) were used to test the difference between groups.
The mean age of 22 males (45.8%) and 26 females (54.2%) were 26.6 years. The subjects were age and sex matched. There were no significant differences in age and gender distribution among the study population.($P>0.05$)
The inter group Bone fill Percentage at various time intervals such as immediate post operative grafted site, 6 weeks and 3 months was statistically significant.($P<0.05$). At 6 weeks follow up Bone fill Percentage compared between group 1 and 3, 1 and 4,2 and 3, 2 and 4 was statistically significant ($P<0.05$) with a mean difference of 59.1%, 62.2%, 47.2% and 50.1 respectively. At 3 months follow up Bone fill Percentage compared between group 1 and 3, 1 and 4,2 and 3, 2 and 4 was statistically significant ($P<0.05$) with a mean difference of 25.6%, 27.7%, 30.2% and 32.3 respectively. At 6 months follow up mean Bone fill Percentage of group I, II, III and IV are 79.6%,79.6%, 82.7% and 86.2 respectively.(Table 1, Graph 1)
The intragroup Bone fill Percentage at various time intervals such as immediate post operative grafted site, 6 weeks, 3 months and 6 months of group 1 and 2 are statistically significant.($P<0.05$) It signifies that there is a gradual increase of bone formation which is digitally evaluated in the radiograph.There is gradual increase in bone formation in Group I and II.Bone fill Percentage of Group 3 and 4 compared at various time intervalwas not statistically significant ($P<0.05$). It signifies that the grafting material present in the extraction socket has occupied the socket and held its position without any statistically significant amount of gain or loss.Although wide variation with statistically significant values were observed wrt bone fill percentage at various intervals immediately after the procedure and in early part of the study, the results more or less evened out by the end of 6 months post operatively. (Table 2, Graph 2)

Figure 1 (1a, 1b, 1c): Surgical procedure for Group I (Control Site)

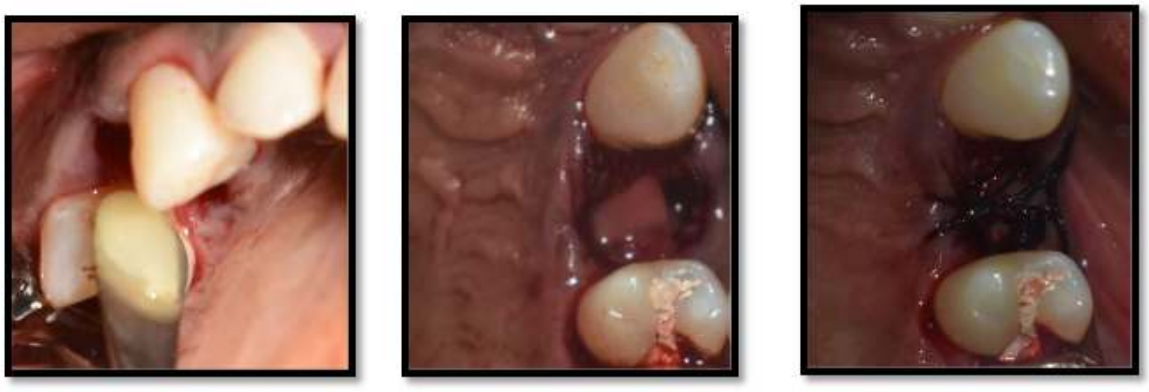


1a- Preoperative site 1b - Extracted site 1c- Suture placed

Figure 2(2a, 2b, 2c, 2d): Surgical procedure for Group II (PRF)

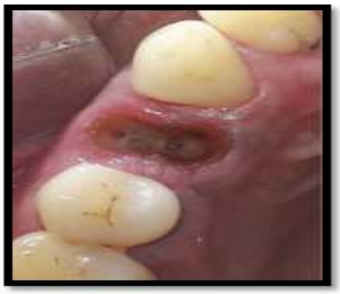


2a- Preoperative site 2b - Extracted site 2c- PRF procured

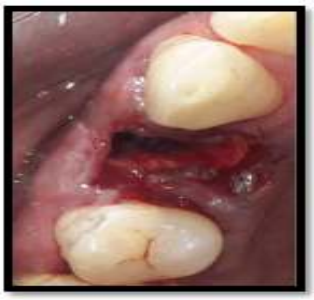


2d- PRF placement 2e- PRF placed 2f- Suture placed

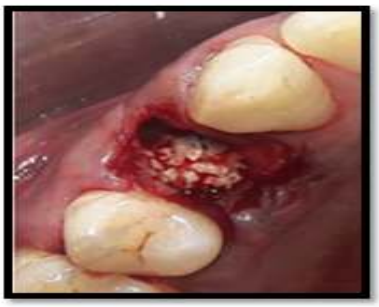
Figure 3 (3a, 3b, 3c, 3d): Surgical procedure for Group III (Xenograft)



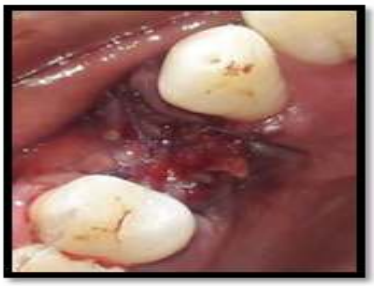
3a - Preoperative site



3b - Extracted site

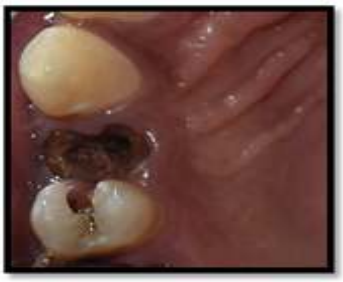


3c- Graft placed



3d- Suture placed

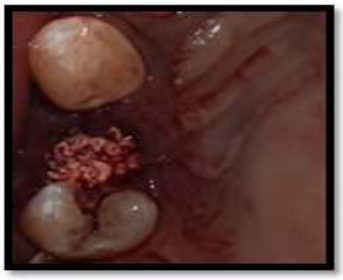
Figure 4(4a, 4b, 4c, 4d, 4e, 4f): Surgical procedure for Group IV {Xenograft + (PRF)}



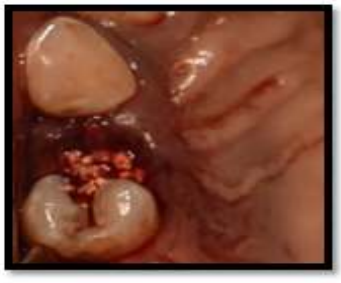
4a- Preoperative site

4b -PRF procured

4c- Graft mixed with PRF



4d- Graft & PRF placement



4e- Graft & PRF placed

4f- Suture placed

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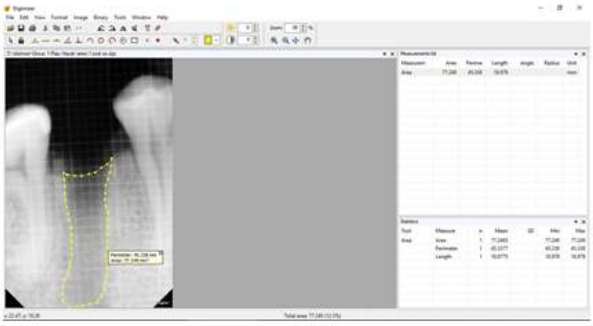
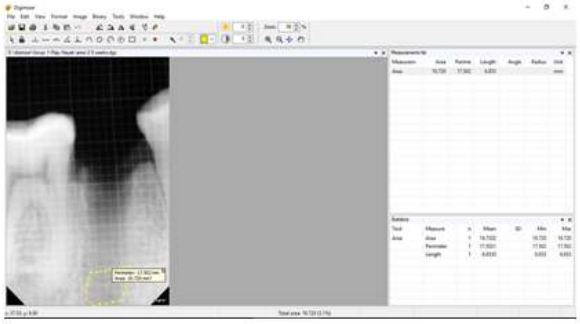
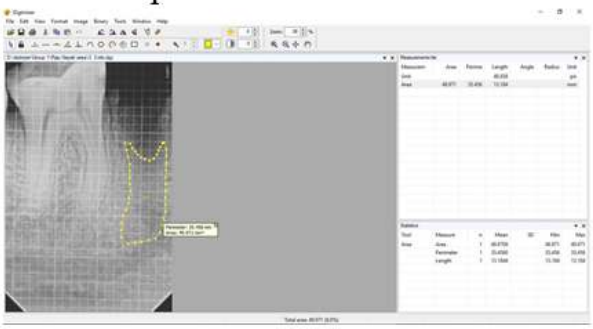
Figure 5 (5a, 5b, 5c, 5d) - Radiovisiography of Group I (Control Site)



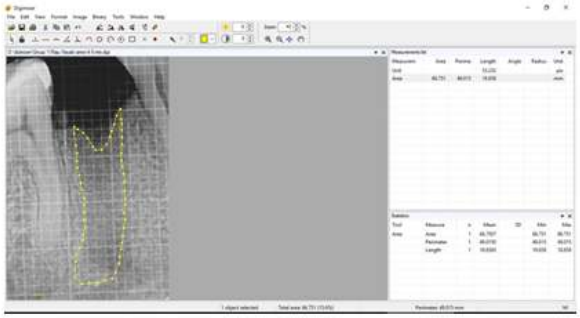
5a- Postoperative



5b- 6 Weeks follow up

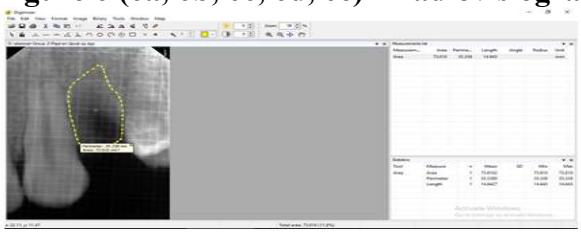


5c- 3 Months follow up

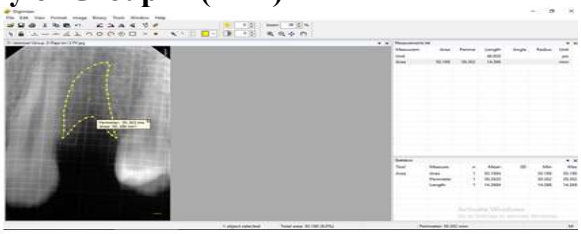


5d – 6 Months follow up

Figure 6 (6a, 6b, 6c, 6d, 6e) - Radiovisiography of Group II (PRF)

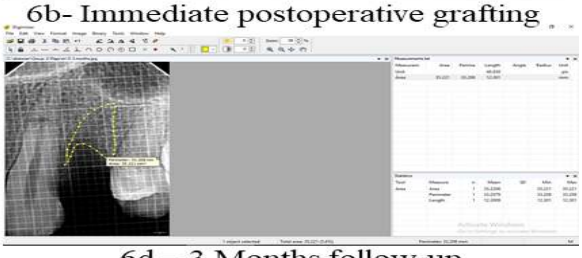


6a- Postoperative



6b- Immediate postoperative grafting

6c- 6 Weeks follow up



6d – 3 Months follow up

6e – 6 Months follow up

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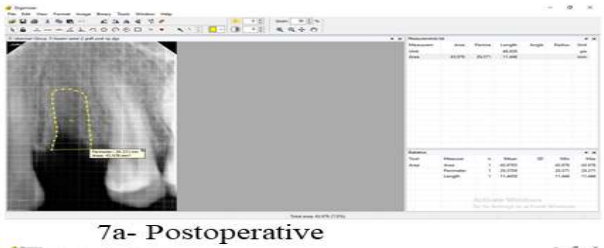
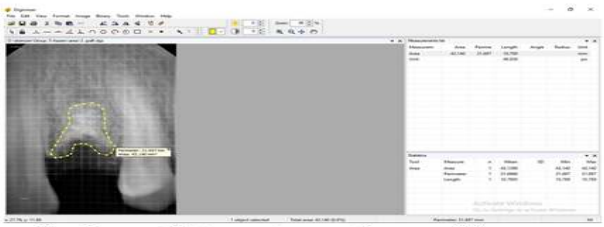
Figure 7 (7a, 7b, 7c, 7d, 7e) - Radiovisiography of Group III (Xenograft)

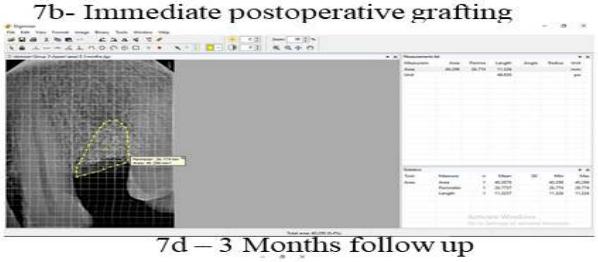


7a- Postoperative

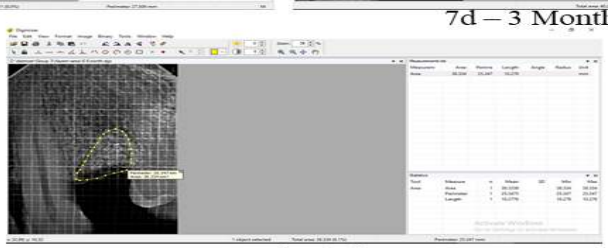


7b- Immediate postoperative grafting

7c- 6 Weeks follow up

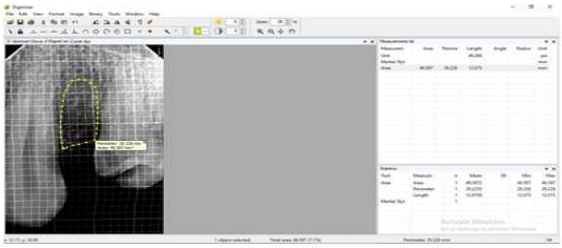


7d – 3 Months follow up

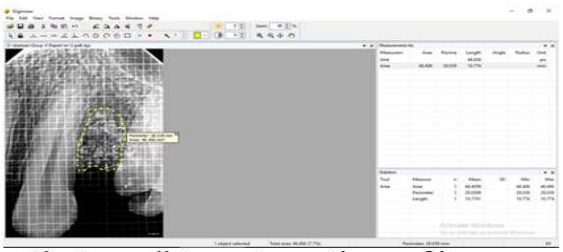


7e – 6 Months follow up

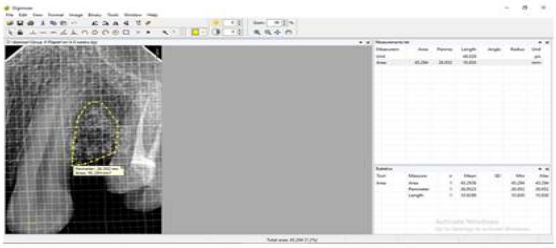
Figure 8 (8a, 8b, 8c, 8d, 8e) - Radiovisiography of Group IV (Xenograft + PRF)



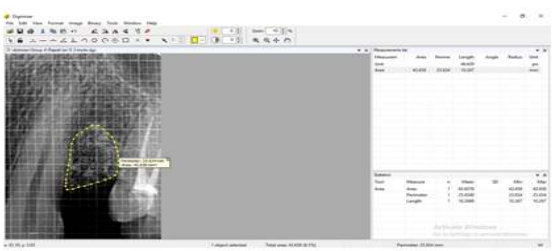
8a- Postoperative



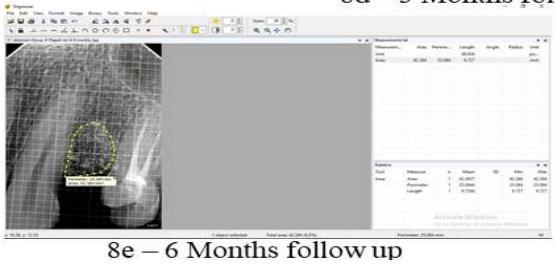
8b- Immediate postoperative grafting



8c- 6 Weeks follow up



8d – 3 Months follow up



8e – 6 Months follow up

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Table 1: Showing the Intergroup comparison of Mean values, Standard Deviation (SD), Median, Minimum and Maximum for Bone fill Percentage using One Way ANOVA test

Visit	Group	N	Mean	SD	Median	Min.	Max.	F value	P value
Imm Post OP	Group 2	12	73.6	4.138	73.2	67.7	82.2	10.075	*<0.001*
	Group 3	12	89.8	17.601	97.0	36.9	99.8		
	Group 4	12	94.1	9.491	96.3	64.4	99.7		
Week 6	Group 1	12	28.4	9.434	27.8	17.1	43.7	92.608	*<0.001*
	Group 2	12	40.3	13.928	38.1	18.3	69.3		
	Group 3	12	87.5	11.346	93.0	56.6	94.6		
	Group 4	12	90.6	10.869	93.0	56.7	97.3		
Month 3	Group 1	12	60.9	9.198	63.0	44.8	79.3	24.996	*<0.001*
	Group 2	12	56.3	17.402	52.7	22.5	91.2		
	Group 3	12	86.5	8.302	90.2	68.2	92.7		
	Group 4	12	88.7	9.411	89.8	59.7	94.8		
Month 6	Group 1	12	79.6	4.801	80.4	71.2	86.4	2.060	0.119
	Group 2	12	79.6	6.686	81.4	66.0	86.9		
	Group 3	12	82.7	10.432	86.7	55.5	88.8		
	Group 4	12	86.2	7.154	86.9	64.5	92.1		

*One Way ANOVA test

Table 2: Showing the Intragroup comparison of Mean values, Standard Deviation (SD), Median, Minimum and Maximum for Bone fill percentage using One Way ANOVA test

Group	Visit	N	Mean	SD	Median	Min.	Max.	F value	P value
Group 1	Week 6	12	28.4	9.434	27.8	17.1	43.7	123.198	*<0.001*
	Month 3	12	60.9	9.198	63.0	44.8	79.3		
	Month 6	12	79.6	4.801	80.4	71.2	86.4		
Group 2	Imm Post OP	12	73.6	4.138	73.2	67.7	82.2	27.073	*<0.001*
	Week 6	12	40.3	13.928	38.1	18.3	69.3		
	Month 3	12	56.3	17.402	52.7	22.5	91.2		
	Month 6	12	79.6	6.686	81.4	66.0	86.9		
Group 3	Imm Post OP	12	89.8	17.601	97.0	36.9	99.8	0.697	0.559
	Week 6	12	87.5	11.346	93.0	56.6	94.6		
	Month 3	12	86.5	8.302	90.2	68.2	92.7		
	Month 6	12	82.7	10.432	86.7	55.5	88.8		
Group 4	Imm Post OP	12	94.1	9.491	96.3	64.4	99.7	1.545	0.216
	Week 6	12	90.6	10.869	93.0	56.7	97.3		
	Month 3	12	88.7	9.411	89.8	59.7	94.8		
	Month 6	12	86.2	7.154	86.9	64.5	92.1		

*One Way ANOVA test

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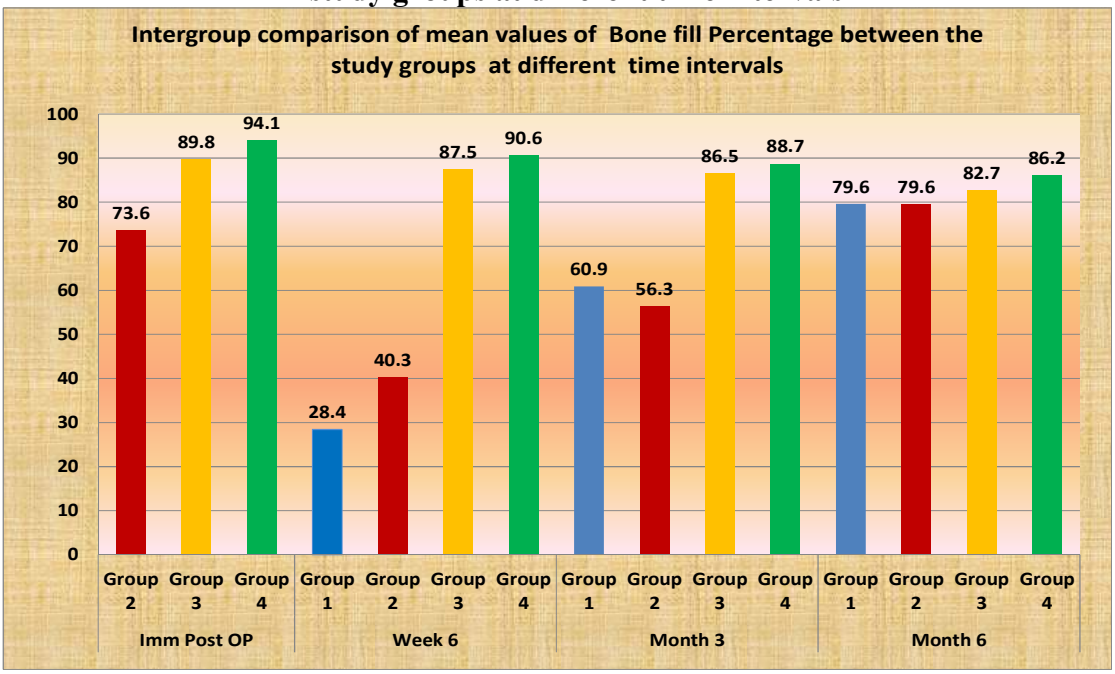
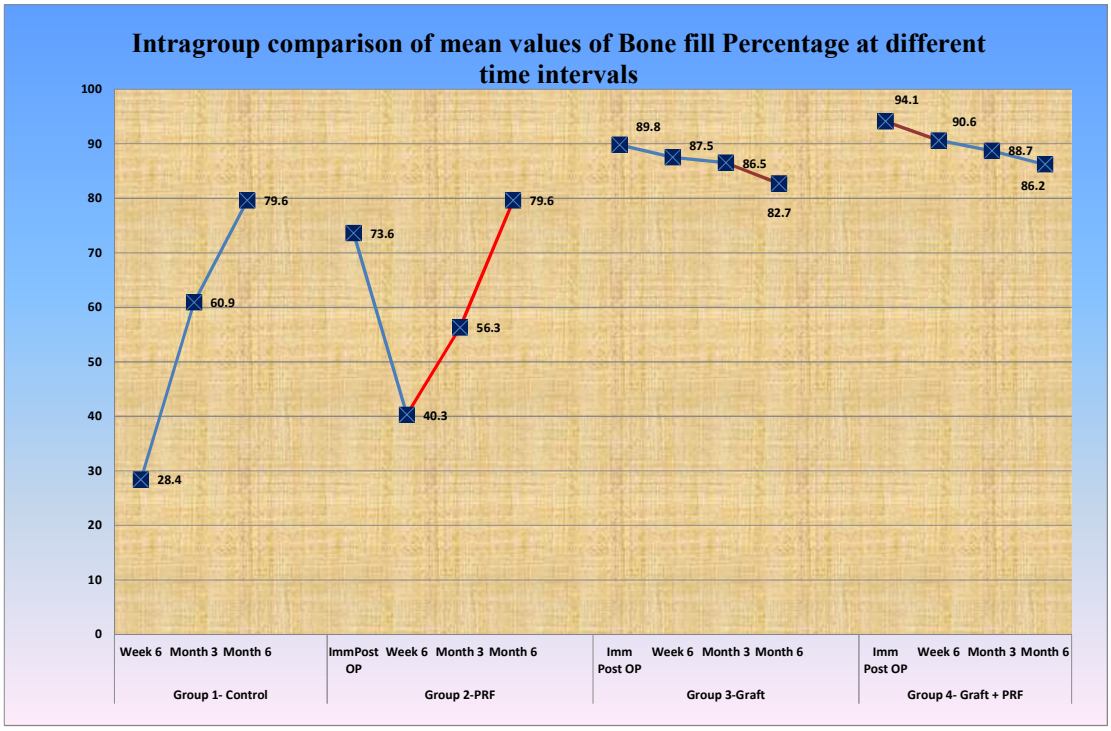
Graph 1: Intergroup comparison of mean values of Bone fill Percentage between the study groups at different time intervals



Graph 2: Intragroup comparison of mean values of Bone fill Percentage at different time intervals



DISCUSSION

We undertook the current study with the objective of assessing the post extraction socket changes when the extraction socket is filled with substitutes such as Xenograft (Cerabone™), Platelet-rich fibrin (PRF) and a combination of Xenograft (Cerabone™) and PRF in comparison with a control group. We compared radiographically using digital evaluation method and assessed bone fill percentages at various time intervals such as 6 weeks, 3 months and 6 months.In the present study patients whose maxillary and mandibular premolars were indicated for extraction were recruited so that adequate bone maintenance can be observed and proper contour can be established at the time of FPD or an implant placement since it is part of the esthetic zone and requires pleasant contoured profile. A similar study done by Schropp et al. (2003)[11]premolar and molar were extracted followed by assessment of bone formation in the alveolus and the contour changes of the alveolar process.

Bone fill gained at various time intervals were measured radiographically with the assistance of grid measurements using Digimizer software version 4.6.1. The bone fill values were obtained in square mm (mm^2). However, we have given concentrated weightage more on bone fill percentage rather than bone fill area as pre-operative socket dimensions vary from sample to sample and hence cannot be standardized. We found similar results at the end of 6 months wrt Bone fill percentage when Group I and II were compared with identical score of 79.6%. Results were slightly better in Group III with 82.8% bone fill percentage. The best result was observed in Group IV with a maximum bone fill percentage of 86.2% at conclusion of 6 month interval.

In our study we incorporated this method of assessing bone fill from Alveolar Crest to the Base of the Socket instead of CEJ as it will be difficult to determine the CEJ at many instances and also in certain periodontal compromised teeth there will be decrease in alveolar bone height which might magnify or exaggerate the bonefill. As crest of alveolar bone is at alesser height than CEJ, the comparatively greater bone fill percentage obtained as compared to Gupta D et al. (2012)[12] can be explained. The results obtained in our study for Group III (Xenograft group) and Control Group are 82.7% and 79.6% compared to that of the above study which was 59.54% and 47.01% for test site and control site respectively.

In another study by Artzi Z et al. (2000) [13]Porous bovine bone mineral **(**PBBM) was grafted in the alveolar socket and was evaluated radiographically for a period of 9 months. Average clinical overall bone fill of the augmented socket sites were 82.3% compared to our study which are 82.7% and 86.6% for Group III and IV respectively for a period of 6 months.

Similarly a study by Schropp et al. (2003) [11] who assessed the bone level radiographically after 12 months was situated 0.3 mm more apical than at baseline which suggest loss of bone in the post extraction socket. Therefore, following extraction of a tooth there is inevitable loss of bone morphology**.** Muñoz-Corcuera M (2015) [14]concluded that beta tricalcium phosphate (β-TCP) facilitated bone formation in the socket and prevent post-extraction alveolar resorption and radiopacity of the graft had aided for differentiating the bone formation and resorption of the graft. Therefore, radiologically it is convenient method for evaluating the above changes in the socket. In a study by Sadeghi R et al. (2016) [15]compared Deproteinized bovine bone mineral (DBBM) and Demineralized freeze-dried bone allograft (DFDBA) with absorbable

collagen membrane. The average loss of alveolar width was 2.26 ± 0.51 mm (28.58%) for the DBBM and 2.3 ± 0.64 mm (29.75%) for the DFDBA group, but the intergroup difference was not statistically significant. Therefore, minimal loss of socket morphology can aid in future FPD and implant placement.

Another study by Thakkar DJ et al. (2016) [16]observed loss of 0.75 mm and 1.08mm of ridge width and 1.36 mm and 1.08mm ridge height loss in combination of DFDBA with PRF and DFDBA group respectively. Thus observing the results, it was proved that using DFDBA combined with PRF had an additional benefit in preserving ridge width better than using DFDBA alone with $P < 0.001$. Mirroring the results of earlier studies, in our study Group IV comprising of PRF and bone graft has resulted in better bone fill percentage than Group III (bone graft). Thus it can be concluded that PRF can be used as an adjunctive with the bone grafts while preserving alveolar socket post extraction.

According to literature Cerabone™ exhibits maximum resemblance to human bone (surface, porosity and chemical composition). The 3-dimensional pores network allows fast deposition and penetration of blood serum and proteins thus serves over a long time period as a reservoir for proteins andgrowth factors.[17] PRF mixed with graft forms a sticky cohesive mass which helps in binding the graft particles to each other. PRF used along with graft is an adjunctive and help in faster healing and bone formation.

Clinically in our study it was observed that there was a gradual decrease in the width of the extraction socket in Group I and II which resulted in a very narrow alveolar ridge but in contrast there were very minimal changes in the morphologic dimension of the ridge in Group III and IV. Therefore it can be concluded that the Xenograft (Cerabone ™) used in the post extraction socket is an ideal material for maintaining the morphologic dimension of the ridge which makes post implant and FPD placement easy.

CONCLUSION

It can be concluded from the current study that residual post extraction alveolar socket preservation limits the morphological changes of alveolar bone and helps to maintain the dimension of the alveolar ridge for future prosthetic rehabilitation. The use of bone graft (Cerabone™) in combination with PRF accorded the best results amongst all the tested groups which comprised of Group I- Control group, Group II- PRF, Group III- Xenograft (Cerabone™), Group IV- Xenograft (Cerabone™) + PRF. Further histological studies to assess bone quality and studies that measure the width and height of the alveolar ridge can be done in future studies.

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