



Comparison of the Efficacy of Platelet-Rich Fibrin and Bone Allograft for Alveolar Ridge Preservation after Tooth Extraction: A Clinical Trial

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ABSTRACT

Objectives: Bone remodeling after tooth extraction results in decreased ridge volume and complicates implant placement. Platelet-rich fibrin (PRF) is a rich source of autogenous cytokines and growth factors; it has been proven to effectively improve soft tissue healing and hard tissue regeneration. This study sought to compare the clinical application of freeze-dried bone allografts (FDBA) and PRF for alveolar ridge preservation after tooth extraction.

Materials and Methods: This clinical trial was conducted on 32 patients presenting for the extraction of hopeless non-molar teeth. The teeth were extracted with minimal trauma, and the samples were randomly divided into two groups (n=16). Tooth sockets were filled with either FDBA or PRF (prepared using 10cc of the patient's blood). Bone regeneration was assessed by evaluating changes in horizontal and vertical bone dimensions after 12 weeks (the time of implant placement) using an acrylic stent fabricated before tooth extraction and a periodontal probe. The results were compared by repeated-measures analysis of variance (ANOVA; $P < 0.05$).

Results: Ridge width showed a significant reduction compared to the baseline in both groups ($P = 0.001$); ridge height changes were not significant ($P > 0.05$). The evaluated groups did not show any significant difference in height/width changes ($P > 0.05$).

Conclusion: The results showed an acceptable efficacy for PRF without graft materials in alveolar ridge preservation. This material is cost-effective and could be easily prepared. PRF application in extraction sockets yielded similar results to FDBA.

Keywords: Alveolar Ridge Augmentation; Allografts; Bone Transplantation; Platelet-Rich Fibrin

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INTRODUCTION

After tooth extraction, the bony socket undergoes resorption in height and width during the process of natural healing and bone remodeling [1]. A literature review reported a 29-63% reduction in ridge width and 11-22% reduction in height following tooth extraction; the fastest and greatest bone resorption was reported in the first 3-6 months [1]. This compromises dental implant placement in extraction sockets in many patients. Alveolar ridge preservation process has been proposed to provide optimal bone dimensions for implant insertion [2,3]. Bone allografts, such as freeze-dried bone allografts (FDBA) with osteoconductive properties, easy application, and low costs, are highly popular and eliminate the need for intraoral or extraoral donor sites [4,5].

Platelet-rich fibrin (PRF) is a platelet product introduced by Dohan et al [6] for use in maxillofacial surgery as a rich source of autogenous growth factors to enhance healing. PRF is a 100% autologous compound containing platelets, leukocytes, and cytokines within a strong fibrin network, which is prepared using 10cc of the patient's blood without any additives (e.g. anti-coagulants or bovine thrombin) [7]. This concentrate contains high levels of growth factors that are released slowly for 7 to 14 days [7]. Many studies have shown that PRF can enhance soft tissue healing [8], reduce pain and swelling, and accelerate epithelial closure after surgery [9,10]. Some studies have reported the successful use of PRF for the management of gingival dehiscence and treatment of gingival recession, periodontal intrabony defects, peri-implant bone defects, as well as sinus lift surgery [8,11]. Gassling et al [12] showed that PRF, as an osteoblast-seeded scaffold, can expedite bone formation. In an animal study, the scaffold-free PRF membrane showed better results for bone regeneration in calvarial defect models [13].

However, it is still unclear if PRF alone could clinically improve bone healing and influence bone quality compared to routinely used grafting materials like FDBA. This study sought to compare the clinical application of

FDBA and PRF for alveolar ridge preservation after tooth extraction.

MATERIALS AND METHODS

This randomized controlled clinical trial was conducted on 32 patients over 18 years of age (average age of 38 years), who referred for extraction of hopeless teeth. All patients gave their informed consent before their inclusion in the study. The study protocol has been registered and approved in the Institutional Ethics Committee (IR.TUMS.REC.1394.391). The present study was performed considering the ethical standards of the revised Helsinki Declaration.

The reasons for tooth extraction included root fracture, failed root canal therapy, and extensive non-restorable caries. The exclusion criteria included a history of systemic disease and head/neck radiotherapy, use of drugs affecting bone metabolism, smoking more than 10 cigarettes per day, the presence of significant periapical or periodontal lesions around the respective teeth, and the presence of dehiscence or fenestration larger than 3mm in the buccal bone plate. The study protocol was thoroughly explained to the patients, and they willingly signed written informed consent forms.

The teeth were extracted with minimal trauma using a periosteal elevator. Care was taken to prevent any bone or soft tissue defect. Patients were divided into two groups (n=16) using block randomization. In group A, the extraction socket was filled with FDBA (CenoBone®; Tissue Regeneration Corp., Kish Island, Iran) without flap elevation. The socket was covered using a free palatal mucosal graft obtained by the pouch technique. For group B, 10cc of blood was drawn from each patient and centrifuged at 2700 revolutions per minute (rpm) for 12 minutes to obtain PRF, according to a protocol explained by Dohan et al [6]. The extraction socket was filled with PRF and covered using a membrane made of PRF. Next, a 0.2% chlorhexidine mouthwash (twice a day), antibiotics (Amoxicillin 500mg, every 8 hours for 7 days), and analgesics (Ibuprofen 400mg, every 6 hours) were prescribed. All patients received postoperative instructions.

To assess the dimensional changes of the residual bony ridge, the horizontal and vertical ridge dimensions were recorded by the bone sounding process immediately after extraction (time zero) and after 12 weeks (at the time of implant insertion) using a periodontal probe and an acrylic stent fabricated according to the pre-operative dental cast of each patient. The acrylic stent was stabilized on adjacent teeth. For recording the horizontal dimensions, the buccolingual distance between three points at the mesial, distal, and central aspects of the socket, marked on the stent, was measured using a probe. Vertical changes and crestal bone resorption were recorded by measuring the distance from the stent's border to the bone crest at the same points. The data were statistically analyzed using SPSS 22 (SPSS Inc., Chicago, IL, USA) and multivariate tests. Repeated-measures analysis of variance (ANOVA) was used to compare changes in bone dimensions at two specific time points by considering the type of material (PRF or FDBA) as a between-subject factor (P-values under 0.05 were considered significant).

RESULTS

Four males and 12 females with a mean age of 37.25 years (ranging from 22 to 55 years) were evaluated in the FDBA group while eight males and eight females with a mean age of 30.81 years (ranging from 21 to 50 years) were assessed in the PRF group. Eleven maxillary and five mandibular teeth and 13 maxillary and three mandibular teeth were evaluated in the FDBA and PRF groups, respectively.

The mean±standard deviation (SD) changes in ridge width and height of the PRF group are summarized in Table 1. There was a statistically significant width reduction compared to the baseline (P=0.001); however, height changes were not statistically significant (P>0.05).

Table 2 summarizes the mean±SD changes in ridge width and height in the FDBA group after treatment. The results showed a significant reduction in width compared to the baseline (P=0.001). No statistically significant changes were seen in height at the distal, mid-buccal, and mesial aspects (P>0.05).

Figure 1 shows the changes in the PRF and FDBA groups; height and width changes of the alveolar ridge were not statistically significant (P>0.05).

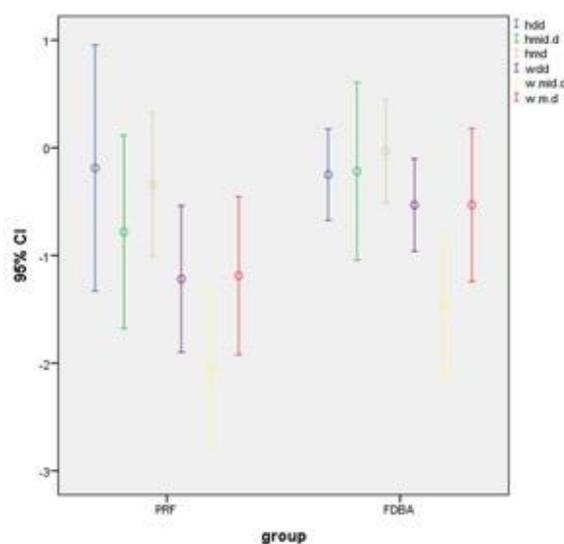


Fig. 1. Error bar of mean changes [95% confidence interval (CI)] in ridge height and width at the mesial, distal, and mid-buccal aspects in the two groups (after treatment compared to the baseline)

Table 1. The mean changes (mm) in the height and the width of the ridge over time in the platelet-rich fibrin (PRF) group

	Position	Baseline	After treatment	P-value	Changes
Height	Distal	7.87±1.27	7.68±2.25	0.45	0.18±2.14
	Midbuccal	9.06±2.05	8.28±1.58	0.09	0.78±1.68
	Mesial	7.65±1.35	7.31±2.12	0.08	0.34±1.24
Width	Distal	6.78±1.06	5.56±1.59	0.001*	1.21±1.27
	Midbuccal	7.75±1.21	5.68±1.63	0.001*	2.06±1.40
	Mesial	6.93±1.10	5.75±1.69	0.001*	1.18±1.37

*The difference was statistically significant

Table 2. The mean changes (mm) in the height and the width of the ridge over time in the freeze-dried bone allograft (FDBA) group

Position		Baseline	After treatment	P-value	Changes
Height	Distal	7.28±1.15	7.03±0.97	0.45	0.25±0.79
	Midbuccal	8.56±1.49	8.34±1.38	0.09	0.21±1.54
	Mesial	7.43±0.92	7.40±1.11	0.68	0.03±0.90
Width	Distal	6.28±1.50	5.75±1.37	0.001*	0.53±0.80
	Midbuccal	7.43±1.45	5.96±1.10	0.001*	1.46±1.25
	Mesial	6.28±1.63	5.75±1.27	0.001*	0.53±1.33

*The difference was statistically significant

Accelerated healing and maturation of soft tissue coverage of the extraction socket were clinically seen in the PRF group two weeks after surgery.

DISCUSSION

This clinical study was conducted on 35 patients, out of which, three were lost to follow-up and excluded. The remaining 32 patients were randomly divided into two groups of 16 to compare the clinical results of FDBA and PRF application for alveolar ridge preservation after tooth extraction. The results showed a significant decrease in ridge width after 3 months in both groups ($P < 0.05$). The reduction in ridge width was 1.1-2.0 mm in the PRF group and 0.5-1.4 mm in the FDBA group. The reduction in ridge height was 0.1-0.7 mm in the PRF group and 0.0-0.2 mm in the FDBA group. These numbers are, however, smaller than normal changes after tooth extraction and natural bone healing as reported in a systematic review [14]. Without ridge preservation, the mean changes in ridge width and height after six months were 3.87mm and 1.67mm, respectively. The greatest width reduction and the least height change have been reported in the buccal plate and next to adjacent teeth, respectively [14]. These findings are in agreement with the results of the present study.

The efficacy of FDBA has been well documented. Iasella et al [5] reported 1.2mm (13.04%) of alveolar width resorption [5]. Jambhekar et al [15] reported a 1.63mm reduction in the buccolingual ridge width following the use of FDBA. Maximum change of

1.4mm in ridge width and 0.2mm in ridge height, in the present study, were both clinically acceptable.

The results of the present study indicated successful ridge preservation results with FDBA and PRF with no significant differences. Although no additional biomaterial was used as a space maintainer in the PRF blood product, the results were not significantly different from those of FDBA, which is a bone allograft. However, changes in the FDBA group were smaller than that in the PRF group.

PRF has strong and long-term effects on the proliferation and differentiation of osteoblasts under in-vitro conditions [16,17]. The growth factors found in PRF have four key functions including "angiogenesis, immune control, circulating stem cells trapping, and epithelialization" [18]. However, the results of clinical studies on PRF for bone regeneration are controversial. In a study by Suttapreyasri and Leepong [19], reductions in ridge width after eight weeks were not significantly less in the PRF group compared to the control group; however, in the control group, the reduction in width continued after eight weeks while the PRF group reached a plateau after this time [19]. Hauser et al [20], in 2013, clinically and histologically assessed the use of PRF after tooth extraction to improve the microarchitecture and intrinsic bone tissue quality. The results showed greater bone fill and higher quality of bone when PRF filled the extraction sockets [20]. They also noticed that elevating a mucosal flap reversed all the advantages of PRF with regard to the trabecular thickness and bone mass [20].

Improved three-dimensional (3D) structure of bone and positive effects on bone quality can be justified by the presence of growth factors trapped in PRF and their effect on recently formed bone trabeculae in the socket [20].

The present study suggested that the application of PRF in the socket of teeth extracted with minimal trauma is easy and inexpensive and can yield optimal results similar to the application of FDBA. Future studies are suggested to assess the short-term outcome of PRF application and the stability of the long-term results. Evaluative studies on extraction sockets missing at least one bony wall are also proposed, as well as differentiation analyses of the effect of patients' age and gender.

CONCLUSION

Considering the limitations of the present clinical study, the following conclusions can be made:

1. The results showed the optimal efficacy of PRF without graft materials for alveolar ridge preservation after tooth extraction.
2. Although bone resorption in the FDBA group was less than that in the PRF group, there was no statistically significant difference in the efficacy of PRF in reducing alveolar ridge resorption compared to routinely used FDBA.
3. The ridge width resorption was statistically significant in both PRF and FDBA groups compared to the baseline.
4. There was no statistically significant bone height resorption in the PRF and FDBA groups compared to the baseline bone height.

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CONFLICT OF INTEREST STATEMENT

None declared.

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