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Platelet rich fibrin as a membrane for coverage of immediate implants: Case-series study on eight patients

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Abstract

Purpose: To evaluate the efficacy of platelet rich fibrin as a membrane for coverage of immediate implants in the maxillary anterior region.

Patients and methods: Twelve implants were inserted into eight adult patients indicated for extraction & immediate implant insertion in one or more of the upper anterior teeth. A venous blood sample of 10 cc was obtained for each single implant. After implant placement, the peri-implant defect was filled with a mixture of autogenous bone (collected from the chin) and fibrin. A platelet rich fibrin membrane was used to cover the implant site. Clinical & radiographic evaluation was performed immediately, 3 and 6 months postoperatively to evaluate soft tissue healing & crestal bone stability.

Results: After 6 months, the marginal bone was stable in 83% of cases. Clinically, good soft tissue coverage was obtained. Radiographically, bone height showed a statistically significant decrease in the distal side while there was no statistically significant decrease at the mesial side. The change in defect depth was limited to 2 mm.

Conclusion: Platelet rich fibrin provided good soft tissue coverage over the immediate implants and it enhanced bone stability. The technique was easy to perform with good esthetic results.

Keywords: Guided bone regeneration; Immediate implant; Platelet-rich fibrin

1. Introduction

Regarding immediate implants' esthetics and soft tissue handling, four factors are significant: the width and position of attached gingival, the buccal volume (contour) of the alveolar process, the level and configuration of the gingival margin & the size and shape of the papillae. These four factors are greatly affected by means of closure of the extraction socket [1]. One of the main challenges confronting the surgeon during immediate implant placement is primary

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socket closure which may be difficult due to the opening left by the extracted tooth.

Although not advocated, the labial tissue is often reflected to approximate the tissues over the socket defect. This technique compromises the blood supply of the labial cortical bone and also decreases the amount of attached gingival as it is placed over the extraction socket [2]. As an alternative a free graft, sub-epithelial connective tissue graft or different types of membranes could be used [3].

Membranes used with guided bone regeneration (GBR) fall under 2 main categories. They are either resorbable or non-resorbable membranes, the main disadvantage of which is that membrane exposure may result in bacterial contamination and early removal of the membrane. To avoid these problems, clinicians have investigated the benefits of using biodegradable barriers [4].

Platelets are primarily involved in the wound healing via blood clot formation and release of growth factors which initiate and support wound healing [5]. Choukroun platelet-rich fibrin (PRF) is a second generation of platelet derivatives after platelet rich plasma (PRP). It can be prepared by a single step and does not require any additives [6]. PRF provides a fibrin matrix enriched with platelets, leukocytes and growth factors [7].

A fibrin network could provide more efficient cell proliferation and migration necessary for tissue regeneration. When fibrin is used with the autogenous bone graft, however, it can increase bone formation, and act as a scaffold for the restoration of bony defects [7]. Fibrin is a recognized support matrix for bone morphogenic protein (BMP) transplants. Thus, PRF, as a natural and optimized blood clot, seemed the adequate adjuvant to secure this technique and to improve the guided tissue regeneration [8].

One of the main differences between the PRF concept and most PRPs systems is that PRF production process is completely natural, with no use of anticoagulant during blood harvest nor bovine thrombin and calcium chloride for platelet activation and fibrin polymerization. PRF is rich in growth factors such as platelet derived growth factor (PDGF) and tumor growth factor (TGF) alpha, beta [9]. These growth factors are sustainably released for at least 1 week up to 28 days [10], allowing PRF to stimulate the environment for a significant time during wound healing.

Recently, other PRF clinical applications were described, which included: a substitution biomaterial during sinus elevation to reduce the healing time for implant placement [11]. It is an inexpensive and easily handled material with healing properties on the sinus membrane and bone [11]. PRF used in periodontal osseous defects achieves probing depth reduction, clinical attachment gain, and intensity increase of radiography over a 6-month period [12].

It was hypothesized that early exposure of non resorbable membranes might cause bacterial contamination and early removal of the membrane. The present study was performed to evaluate the effectiveness of PRF membrane in obtaining primary soft tissue coverage and maintaining bone around immediate implants.

2. Patients and methods

2.1. Surgical technique

Twelve immediate submerged implants inserted into the anterior maxilla of eight patients (7 females and 1 male) of ages ranged from 22 to 40 years. The inclusion criteria involved patients who had upper anterior hopeless tooth/teeth indicated for extraction & immediate implant insertion. Exclusion criteria were any local or systemic conditions that may interfere with bone healing and tissue regeneration, traumatic occlusion, smokers, and bad oral hygiene. All patients had complete sets of (clinical, radiographic data, study casts and intraoral radiographs).

The target tooth was atraumatically extracted using the periotome then the socket was thoroughly debrided using small curette and proper irrigation. For all patients the autogenous bone graft was collected from the chin (Fig. 1) then a bone mill was used to cut the collected bone cores into particulate bone graft (Fig. 2).

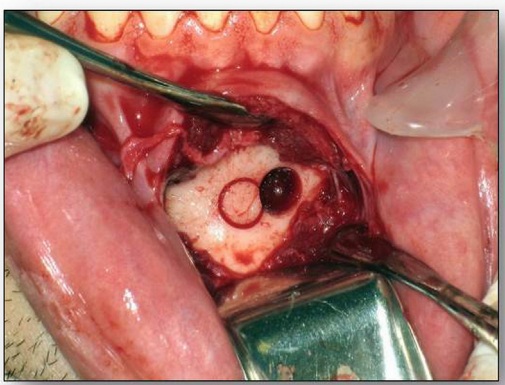

Fig. 1. The trephined bone before and after separation.

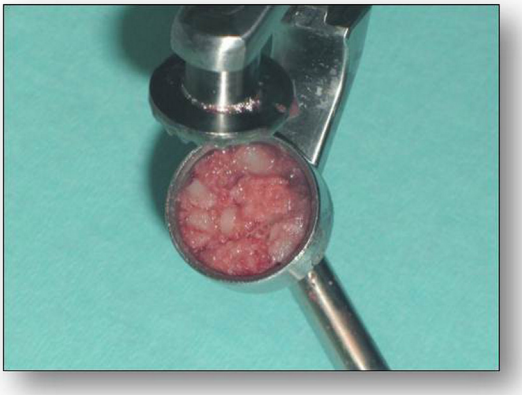

Fig. 2. The bone graft milled into particulate bone.

A conservative full-thickness flap (preserving the interdental papilla) was elevated to expose the osseous defect on the buccal side [13]. Standard drills of sequential diameters were used using the socket walls and the palatal bone as guiding planes. Just before flap closure, the implant was screwed into the bone and the particulate bone graft (mixed with PRF) was introduced to the peri-implant defect (Figs. 3 and 4).

2.2. Preparation of PRF

PRF was prepared according to Dohan et al. [14]. A blood sample of 10 ccs was obtained from the patient for each single implant. The blood sample is then put to a 10-ml B.D vacutainers without an anticoagulant

Fig. 3. The combination of the particulate bone graft with the PRF piece.

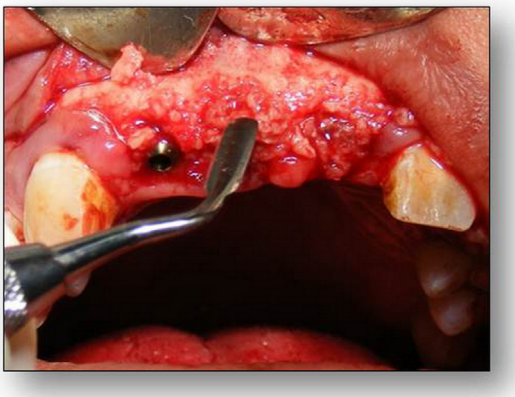

Fig. 4. Packing the graft–PRF combination in the peri-implant defect.

and centrifuged at 3000 rpm[1] for 10 min. The result was platelet poor plasma in the top of the tube, red corpuscles in the bottom and a fibrin clot (PRF) in-between. PRF was gently pressed on to get a membrane using a sterile glass slab against a perforated metal tray and the membrane used to cover the fixture and the peri-implant graft extending on the labial bone (Figs. 5 and 6), then sutured under the flap (without approximation of the buccal and palatal flaps) (Fig. 7).

Clinically, the labial bone defect (height and width) was measured using a graduated periodontal probe intraoperatively (after implant placement and before graft and membrane application) and at six months post-operatively and recorded in the patient chart using the following reference points: *Defect height*: the distance from the most apical aspect of the buccal crestal bone to the coronal aspect of the implant body (Fig. 8), *Defect width*: the widest mesio-distal dimensions of the buccal bony defect. The bony defect surface area was calculated as half ellipses: Defect height × Defect width × 1/4Π (0.79), and recorded in the patient chart.

Patients were recalled 48 h following surgery to monitor soft tissue healing and detect any early post-operative complications. Regular checkups were arranged on weekly bases of the first month then monthly for 5 months. The recipient site was inspected to evaluate healing, PRF epitheleialization and integration with the surrounding gingival. The implant loading was delayed after six months.

On the second stage (after 6 months) surgery conservative full thickness three-line incision flap was

[1] Revolution per minute.

Fig. 5. The PRF obtained.

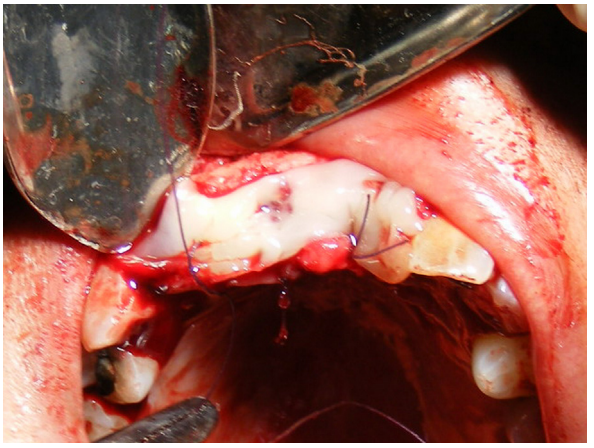

Fig. 6. The PRF membrane covering the fixture, sutured.

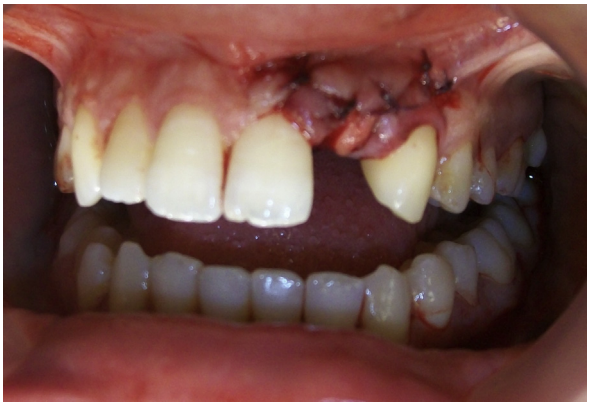

Fig. 7. Suturing the flap over the PRF membrane (light pink in color).

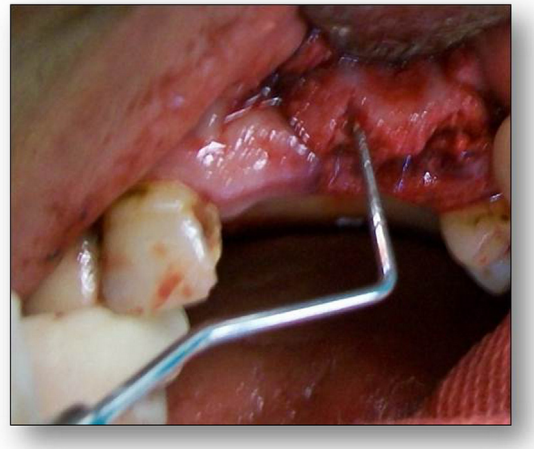

Fig. 8. Measuring the buccal defect height.

reflected over the implant site preserving the inter-dental papillae. All soft tissues over the cover screw were removed and the area was flushed with saline for showing the regenerated bone around the implant. The regenerated defect height and width were measured again following the same reference points used during first stage surgery and were used to calculate the buccal defect surface area.

Cone beam computed tomogram (CBCT) was taken immediately, at 3 month and at 6 month post-operatively to evaluate the change in the buccal defect height. On the corrected sagittal and coronal cuts, the horizontal contour line was placed at the top of the implant then the height of the buccal defect was measured from the mesial, distal and middle (cross-sectional) aspects of the implant on the sagittal cuts in the form of a line drawn parallel to the vertical contour line joining the buccal alveolar bone till the horizontal contour line (Fig. 9).

Once all the readings completed, the stored images were interpreted and measured at the end of the follow up period by two examiners at two different sessions and the inter-observer error was then calculated and the mean of the trials was recorded and included in the statistical analysis.

2.3. Statistical analysis

Clinical results were statistically analyzed in the form of the mean, standard deviation (SD) values and Wilcoxon signed-rank test was used to obtain the changes in mean defect height, width and area after 6

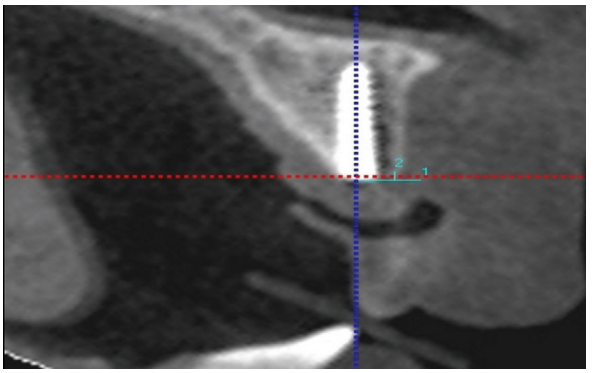

Fig. 9. Measuring the bone height on the sagittal cut.

months. However, the CBCT data of marginal bone defect height was presented in the form of mean, standard deviation (SD) values and results of Friedman's test for the changes in mean defect height after 3 and 6 months. Statistically *Significant at* $P \leq 0.05$.

3. Results

3.1. Recipient site evaluation

One Week post-operative the initial signs of soft tissue healing was noted. Implants and bone grafts were entirely covered without any soft tissue dehiscence. Two weeks post-operatively, neither the graft nor the implant was exposed. At three weeks, a small cleft between the buccal and palatal flaps was still noticed and the PRF blended well with the surrounding tissues. At one month: two out of twelve covering screws were exposed, yet still preserving healthy mucosal collars around while other cases show completed coverage over the implants. At 3 and 6 months: no significant clinical change was noticed (Fig. 10).

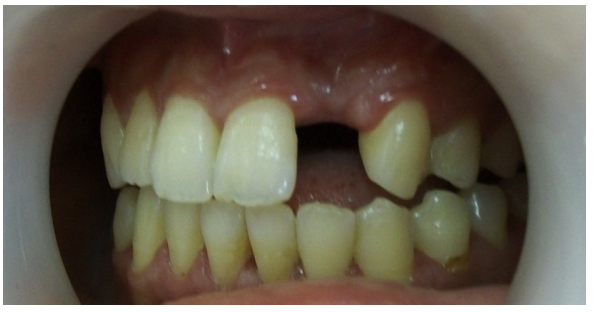

Fig. 10. Six months post-operatively before re-entry surgery.

3.2. Clinical changes in buccal defect measurements

3.2.1. Intra-operative buccal bone defect measurements

See Table 1.

3.2.2. Buccal bone defect measurements after 6 months

3.2.2.1. Defect height. There was not statistically significant decrease in mean defect height after 6 months (Diagram 1).

3.2.2.2. Defect width. There was a statistically significant decrease in mean defect width after 6 months (Diagram 1).

3.2.2.3. Defect surface area. There was a non-statistically significant decrease in mean defect area after 6 months (Diagram 2).

3.3. Radiographic changes in the buccal defect by time in CBCT

3.3.1. Defect height

At the mesial side of the buccal defect, there was non-statistically significant change in mean defect height after 3 months and after 6 months. In a cross-section and at the distal side, there was a statistically significant decrease in mean defect height after 3 months. From 3 months to 6 months, there was non-statistically significant decrease in mean defect height. Through the whole study period (Immediate– 6

Table 1
Intra-operative defect measurements.

Patient no.	Tooth	Buccal defect height (mm)	Buccal defect width (mm)
1	LT2	3	5
2	LT1	2.5	5
	RT1	1.5	3
	RT2	2	4.5
3	LT1	2.5	5.5
4	LT2	2.5	4.5
5	RT1	1	4
	RT2	3	5
6	LT2	3	3
	LT3	1	5
7	LT2	3	3.5
8	RT2	2.5	5

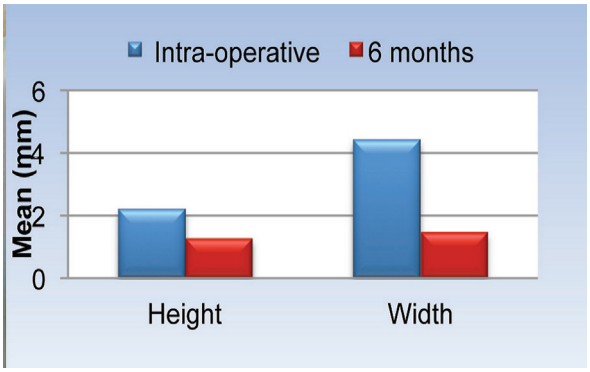

Diagram 1. Bar chart representing mean clinical defect height and width.

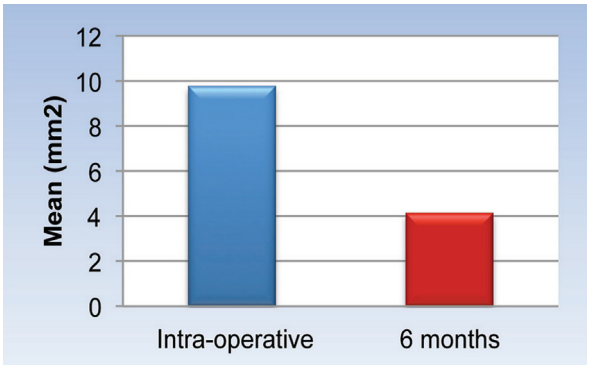

Diagram 2. Bar chart representing mean clinical defect area.

months), there was a statistically significant decrease in mean defect height (Table 2).

4. Discussion

The main risk factors guiding the success of immediate implantation procedure involve 3 parameters namely, the presence of infection at the site of implantation, the bony defect encountered with immediate implantation and the flap closure over the implant.

The scope of this study was directed towards one of these limiting factors, which is the technique of flap closure over immediate implants. The other two factors were stabilized. The selected cases were free from infection or any radiographically detected periapical lesions.

Marginal bone defects assessed in the current study were limited to a one wall defect on the buccal side classified as Meltzer [15] *(class II)* and Garber and Belser [16] (classes I and II) which could not be assessed by the preoperative clinical and conventional radiographic examinations Accordingly, the type and classification of the buccal defect was addressed at the time of tooth extraction. Extraction sites within the scope of the present study were implanted and grafted. Cases which did not fulfill the study criteria were excluded, grafted and scheduled for delayed implantation.

According to Meltzer, Garber and Belser recommendations, class I and II defects are indicated for autogenous bone grafting and GBR. Particulate autogenous bone (collected from the chin) mixed with PRF was sufficient to fill the defect in all cases. However, circumferential defects which were encountered with some cases (if the marginal void is 2 mm or wider) [17,18] were also filled but only the buccal defect was measured and evaluated.

The radiographic parameters addressed in this study included buccal defect height. Regarding it, there was a statistically non-significant decrease in mean defect height after 3 months and after 6 months at the mesial side. At the distal side and in a cross-section, throughout the whole study period (Immediate–6 months), there was a statistically significant decrease in mean defect height.

It means that there was more bone deposition in the distal and cross-sectional than the mesial. This false impression resulted from difficulty of standardization of the peri-implant defects preoperatively together with each implant angulation. Moreover the small sample size could be a factor responsible for this false impression.

In the current study PRF membrane was utilized to cover the peri-implant defect. PRF preparation technique does not require any additives. PRF has a natural fibrin framework which can protect growth factors from proteolysis and keep their activity for a relatively longer period and stimulate tissue regeneration effectively [19].

Table 2
The mean, standard deviation (SD) values and results of Friedman's test for the changes in mean defect height after 3 and 6 months.

	Immediately post-operative		3 months		6 months		*P*-value
	Mean	SD	Mean	SD	Mean	SD	
Mesial	1.98	0.59	1.63	1.40	1.53	1.38	1.000
Cross-section	2.08[a]	0.65	0.90[b]	1.48	0.10[b]	0.27	0.001*
Distal	1.90[a]	0.80	0.83[b]	1.43	0.03[b]	0.09	0.001*

*Significant at $P \leq 0.05$, different letters are statistically significantly different.

As a natural strong fibrin matrix, PRF concentrates almost all platelets and leuckocytes of the blood harvest [20] and represents complex architecture as a healing matrix. This unique structure of PRF may be capable of acting as a vehicle for carrying cells necessary for tissue regeneration.

PRF provided complete coverage of the implants and blending to the surrounding tissues. PRF technique was easy to perform. PRF is known to release growth factors of at least 7 days [21]. The use of PRF to achieve tight soft tissue closure over immediate implants had many advantages as avoiding creation of donor site defects in case of using different types of flaps, avoiding membrane exposure and infection which are frequently seen in cases of non resorbable membranes.

The PRF membrane was left exposed to the oral environment and no adverse local reaction was seen. Moreover being autogenous graft, no adverse immune response was expected and it is typically inexpensive and easy to prepare. Meanwhile, exposure of two covering screws did not affect neither the success of those implants nor filling of the buccal defect.

At the distal side and in a cross-section, throughout the whole study period. there was a statistically significant decrease in mean defect height which means bony regeneration not resorption.

Noise affects images produced by CBCT units by producing low contrast resolution, making it difficult to differentiate low density tissues thereby reducing the ability to segment effectively [22]. Moreover cupping artifacts occur when X-rays passing through the implant, it become harder than those passing through the edges of the object due to the greater amount of material the beam has to penetrate. Because the beam becomes harder in the center of the object, the resultant profile of the linear attenuation coefficients appears as a “cup”.

This artifact affects the bone adjacent to and surrounding the implant. The second type of artifact is in the form of dark streaks and bands between dense objects in an image. In dental imaging, this type of artifact can be seen between implants and surrounding bone. Consequently, due to the proximity of the small-sized buccal defects in relation to the implant, the resultant artifacts hindered measuring small width changes and density [22].

Finally the described surgical technique offers valuable and predictable treatment choice for coverage over immediate implants. It provided primary soft tissue closure allowing healing of the bony defects around immediate implants.

5. Conclusion

The results of this study showed that PRF membrane is successful in maintaining particulate autogenous bone graft and achieving primary coverage over immediately placed implants. It provides good esthetic results as regards labial soft tissue contours. PRF could serve as a resorbable membrane for guided tissue regeneration.

Conflict of interest

Authors declare no conflict of interest.

Acknowledgments

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