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Wound healing in compound fractures with significant tissue loss: Treated with platelet-rich fibrin dressing - prospective study

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Abstract

Introduction: Platelet-rich fibrin (PRF) naturally derived second generation of platelet concentrates, which has gained increasing awareness in recent years for regenerative procedures. This biologic additive is completely autologous, easy to prepare, has minimal expense, and possesses prolonged growth factor release, together with several other advantages over traditionally prepared platelet concentrates. However, reference data about potential effect of some PRF components on hard and soft tissue healing are still conflicting. The current article intends to clarify the relevant advances about physiological role of certain PRF components on wound healing in 50 patients. In this study shows effective wound healing in limited duration with p value of < 0.005.

Conclusion: PRF has more regenerative progression than other platelet concentrators easily available, affordable and inexpensive for wound healing in minimal duration.

Keywords: Growth factors, platelet-rich fibrin, platelets, wound healing.

Introduction

The PRF, described by Choukroun, separated from the platelet concentrates, without any anticoagulants. Platelet-rich fibrin therapy is a form of regenerative medicine that can harness those abilities and amplify the natural growth factors your body uses to heal tissue. Autologous platelet-rich plasma is the proposed liquid fraction of autologous peripheral blood with a platelet concentration of a patient's own platelets to accelerate the healing of injured tendons, ligaments, muscles and joints.

PRF can be applied in multiple fields like musculoskeletal, plastic surgery, paediatric, cardiac surgery, gynaecology, urology, ophthalmology field. There has been a surge of PRF use for multiple pathologies, largely due to widespread commercial interest following PRP use in professional sports.

Chronic cutaneous wounds are frequent problem in developing countries and are difficult in healing with lack of growth factor and are frequently complicated with superinfection. PRF contains various growth factors that are necessary in wound healing. Leukocytes releasing from PRF maintain longer time within the wound helpful in inhibiting infections

Various studies have found that growth factors and cytokines play irreplaceable roles in modulating tissues repair and regeneration, especially in bone, skin, cartilage, vascularized tissues, thrombocyte-derived growth factors secreted from PRP during fracture healing can trigger angiogenesis and activate proliferation and chemotaxis of mesenchymal cells, osteoblast, and chondrocytes. High concentrations of these growth factors may accelerate bone healing, and a lack of these factors has been hypothesized as being responsible for the development of non-union. Platelet concentrates rich in growth factors therefore in theory represent an osteo-inductive therapy for the biological augmentation of fracture healing.

The aim of this review was to provide a comprehensive overview of the use of PRF in the treatment of fractures and wound healing. PRF is biocompatible and safe, does not carry infection risk. Applied PRF on 50 patients with large tissue loss and fracture healing. Therefore, we conducted this study to explore the healing rate and complications of PRF dressing in treating chronic wounds.

Methods

This is a prospective randomized controlled study, to test the efficacy of autologous platelet rich plasma in epithelialization and wound reduction in chronic wounds. The study was conducted in the department of orthopaedic surgery, Sri Lakshmi Naryana Medical College, Pondicherry from July 2021 to May 2022. A series of 50 cases was compiled for this study during this period, the source of data were patients attending the outpatient on a regular basis or those admitted as in patients for the management of chronic wounds. 50 patients were studied with PRF dressing. 40 cases have completed the study, 6 was excluded due to infection. 4 patients couldn't have proper follow-up

Follow up: Every week for atleast 8 weeks or when healing was completed

Inclusion criteria

1. Operative cases having an open wound for more than four weeks described as chronic wound.
2. with no active bacterial, viral or fungal infection in wound
3. wound area less than 50 cm not taking any anticoagulants or equivalent functional drugs for one month
4. HB > 9 mg/dl, serum protein > 6 gram/dl and serum albumin > 3gm/dl

Exclusion criteria

1. Platelet count < 1 lac/mm³.
2. Patients with osteomyelitis.

3. Serum creatinine above 1.5 mg/dl.
4. Infection (presence of visible pus or copious wound exudates), presence of cellulitis inadequate perfusion, ischemia, gangrene, patients not willing to take part in the study.

Statistical analysis

Paired T test for quantitative data and Pearson chi square test for qualitative data were used to evaluate the p value. Differences were considered statistically significant, if $p < 0.05$. SPSS Statistics for Windows, version 24 software program was used for statistical calculations

Preparation of materials

Under aseptic precautions 10ml of venous blood was drawn and added to a test tube. In the first spin the test tube is centrifuged at 5000rpm for 15 min to separate the red blood cells from the platelets and plasma. After the first spin, 3 layers appeared. This is due to differences in the density of the blood components: the deep layer consists of red blood cells, the middle layer contains platelets and leukocytes, and the top layer is made up of platelet-poor plasma (Figure 1). 6 Studies have shown that these frequent but small blood draws do not have an effect on haemoglobin, hematocrit, or platelet count. Figure 1: Preparation of material. Dressing technique for conventional dressing the ulcer was cleaned with normal saline and saline soaked gauze piece was kept over the ulcer which was covered with pad and roller bandage.

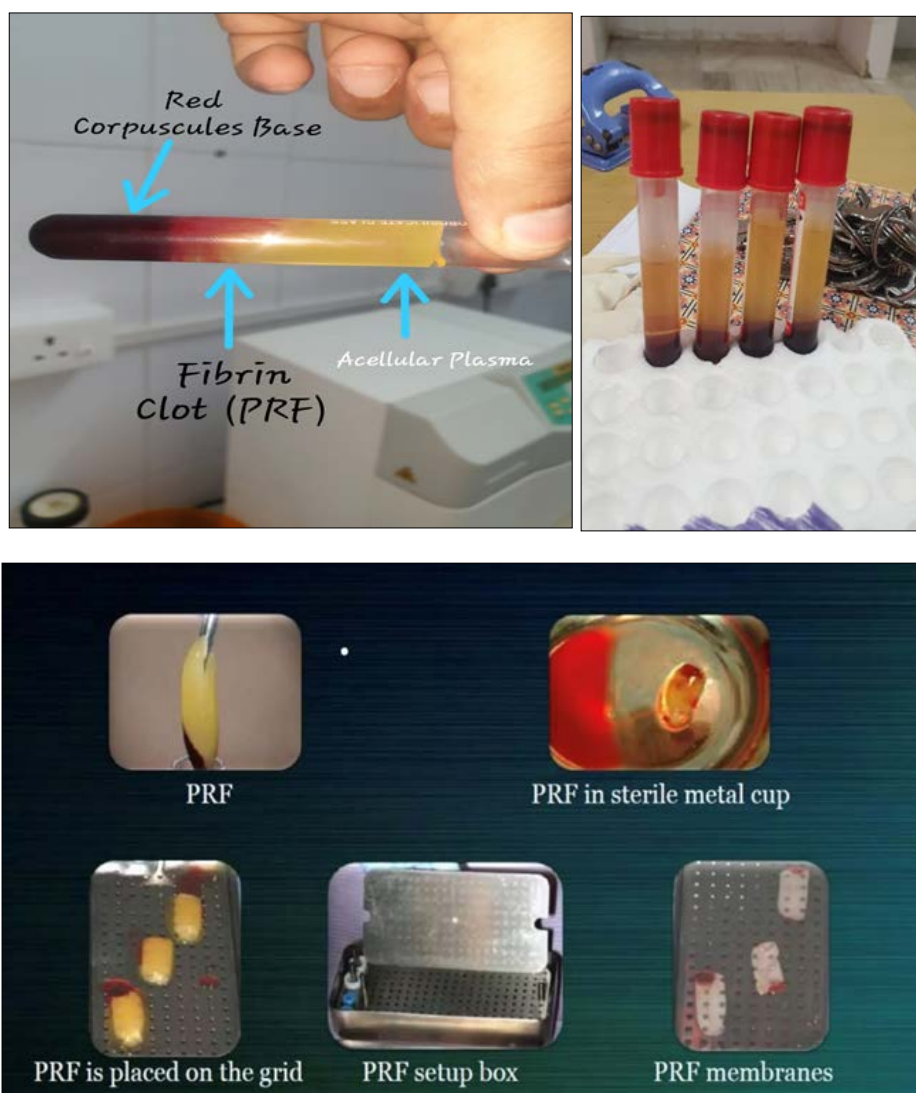


Fig 1: Preparation of material

Merits of PRF

1. Easy for preparation and application.
2. Lack of biochemical modification.
3. Simplified and cost-effective process.
4. Able to support cytokines enmesh and cellular migration.

Demerits of PRF

1. Low quality of PRF is obtained, because of autologous blood so application in general surgery is limited.
2. The clinical benefit of PRF depends on time interval between speed of handling between blood collection and centrifugation as PRF is prepared without any addition anticoagulants.
3. The fibrin matrix contains the circulating immune cells and all the highly antigenic plasmatic Molecules that is why PRF is totally specific to the donor.
4. PRF membrane should be used immediately after preparation as it will shrink resulting in dehydration altering the structural integrity of PRF and leukocytes viability.
5. PRF when stored in refrigerator can result in risk of bacterial contamination.

Results

The present study was conducted in Sri Lakshmi Narayana Medical College, Puducherry. During the study from JUNE 2021 to May 2022, Regarding wound area in Centimeter square, that were performed between consecutive weeks.

Table 1: Study Period, Wound area Mean ± SD, Median (range), and P Compared to previous study period

Study Period	Wound area (cm ²)	P Compared to previous study period
	Mean ± SD, Median (range)	
Before Treatment	7.22 ± 5.80, 6, (1-27.4)	
1 st Week	6.28 ± 5.53, 4.90, (0.5-27)	< 0.0001*
2 nd Week	5.38 ± 5.05, 4.10, (0.39-25.6)	< 0.0001*
3 rd Week	4.49 ± 4.53, 3.15, (0.18-23)	< 0.0001*
4 th Week	3.64 ± 3.91, 2.45, (0.1-19.3)	< 0.0001*
5 th Week	2.79 ± 3.09, 1.85, (0.1-13.7)	< 0.0001*
6 th Week	2.17 ± 2.59, 1.45, (0-10.2)	< 0.0001*
7 th Week	1.59 ± 2.09, 1, (0-8.7)	< 0.0001*
8 th Week	0.98 ± 1.52, 0.40, (0-6.3)	< 0.0001*

Table 2: Baseline characteristics of the studied patients

Variable	Number of Patients	Percentage of Patients
Age (years)	44.18 ± 11.80	(Range 20-65)
Gender		
- Male	42	84%
- Female	8	16%
Diabetes	26	52%
Hypertension	10	20%
Smoking	20	40%
Diabetic Foot Ulcer	24	48%
Venous Ulcer	22	44%
Traumatic Ulcer	4	8%
Duration of Chronic wound before PRF (months)	4 (range 2-6)	
Mean Platelet count	268520 ± 7414	
Mean wound area (cm ²)	7.22 ± 5.80	

Table 3: Reduction in mean wound area and it's percent in consecutive visits

Study Period	Reduction in mean wound area cm ²	Percent of reduction in mean wound area
1 st week	0.94	13%
2 nd week	1.84	25%
3 rd week	2.73	37.8%
4 th week	3.58	49.58%
5 th week	4.25	58.86%
6 th week	5.05	69.94%
7 th week	5.63	77.97%
8 th week	6.24	86.42%

Case 1

46 y/M presented to casualty with A/H/o fall from 3 floor sustained injury to his right foot and back region. Dignosed with L1 burst fracture stabilized with pedicle screw and rods and compound fracture (gustilo Anderson type 3c) in foot fixed with delta frame external fixator. Patient planned for flap reconstruction but ECG shows T wave inversion, RBBB and he was unfit for surgery.

- Patient was not affordable for surgery.
- We planned to give PRF dressing weekly thrice in sterile condition.

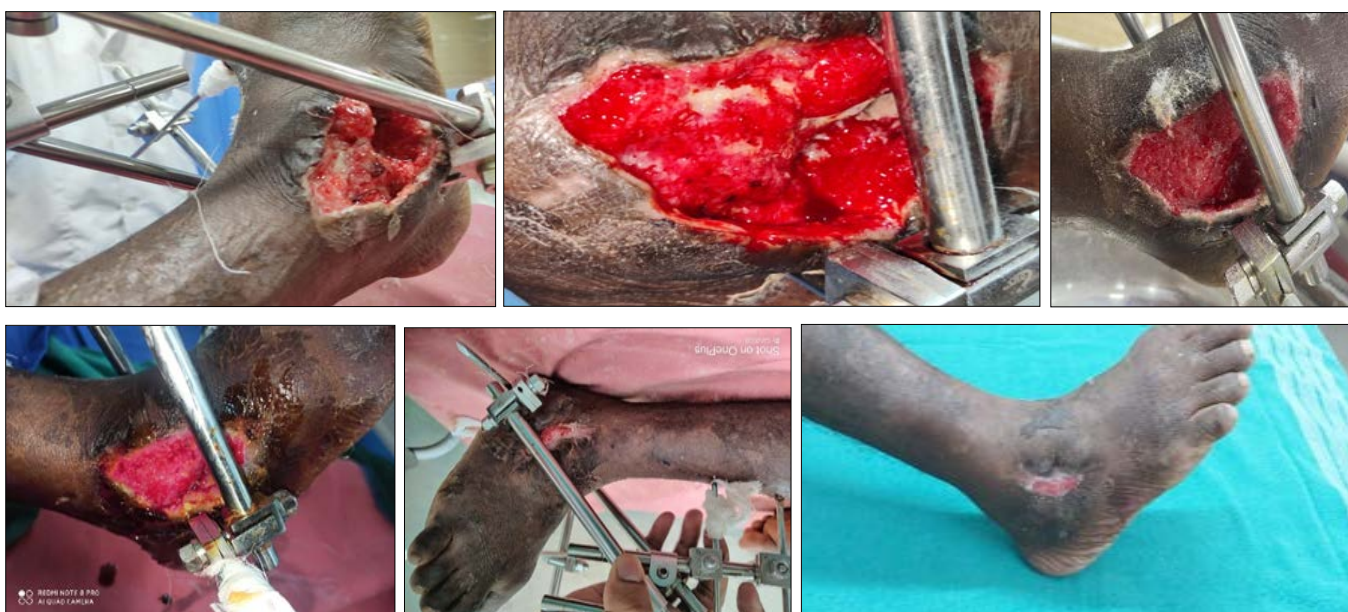


Fig 2: Healing progress using PRF dressing

Case 2

Patient had alleged history of fall from height (6 feet) sustained injury to his left foot and diagnosed to have left compound fracture of calcaneum operated with multiple k

wire fixation wound care was given but plastic surgeon advice for flap reconstruction. Patient had uncontrolled hypertension, multiple seizure episode. Due to delay of flap reconstruction surgery. Patient planned for multiple PRP dressing.



Fig 3: Patient planned for multiple PRP dressing

Discussion

Post-operative and non-healing ulcers are most common complication in Orthopedic condition. The premise for this research stems from the growing interest in the use of regenerative medicine in day-care surgery for the treatment of non-healing wounds after the conventional dressing fails for prolong duration and their outcome. PRF includes a high concentration of PDGF, VEGF, and transforming growth factor (TGF- β). All of which promote cell proliferation and differentiation, culminating. Results of this research are less than those of Pravin *et al.* [2], who conducted a randomised-open label comparative trial in which they included 30 patients with non-healing ulcers of different etiologies. Fifteen patients received L-PRF at weekly intervals for a maximum of six treatments. It demonstrated a greater than 90% reduction in ulcer area in 13 cases (86.6 percent of cases) and a 71-80% reduction in wound area in the remaining two cases from the 15 cases treated with PRF at the end of the sixth week. Whereas, our study demonstrated a 69.94% reduction in wound area in all 50 cases at the end of the sixth week. This may be explained by the fact that just 2 of 15 patients in this research were diabetic, compared to 26 of 50 patients in our study. This may also be explained by the fact that the wound size in this research was not recorded, while in our investigation, some patients had wounds up to 25 cm². Hardikar *et al.* mean time taken for complete healing ulcers 10 weeks in study group when compared to control group it was 20 weeks. In contrast to research conducted by Frykberg *et al.* [1], which revealed a substantial decrease in the area of 63 of 65 ulcers of various etiologies after PRF therapy. This study demonstrated a significant reduction in the area of the ulcers following PRF treatment. Eleven out of 65 ulcers were venous ulcers that responded to therapy with a substantial decrease in the mean percentage of area (43.1%) in 2.3 weeks, while in this research, the mean wound area was reduced by 25% in the second week and 37.8% in the third week. In our study platelet rich fibrin used has treatment for 8-10 weeks after conventional dressing shows significant

healing and closure of wound

Conclusion

1. Patient shows good aesthetic results by application on the day of first dressing after evacuating hematoma and surgical debridement of the wound.
2. PRF shows better healing progress than the PRP from upper layer of plasma (after 1st centrifugation).
3. PRF shows safe, easy to handle, low cost, and risk -free alternative in wound healing for patients with acute trauma wound because leukocytes have antibiotic properties.
4. Patient with severe comorbid conditions and ASA (American society of anaesthesiology) grade-4 are unfit for secondary procedures like plastic surgery are treated with PRP dressing.

Regular follow-up and serial dressing shows good result in healing of wound in greater tissue loss in post-operative compound fracture.

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