RESEARCH PAPER

CLINICAL AND CONE BEAM COMPUTED TOMOGRAPHIC EVALUATION OF PLATELET RICH FIBRIN FOR ENHANCED HEALING OF MANDIBULAR FRACTURE: A COMPARATIVE STUDY

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ABSTRACT

OBJECTIVES: The aim of our present study was conducted to evaluate the efficacy of Platelet Rich Fibrin (PRF) in the healing process of mandibular fractures clinically and radiographically.

MATERIALS AND METHODS: A comparative clinical study was conducted on 20 patients of age 16-50 years with mandibular fractures requiring Open Reduction Internal Fixation (ORIF). Patients were randomly divided into PRF (n=10) and Non PRF (n=10) groups. PRF was placed in the fracture segment after reduction. Follow up was carried out on post operative day one, three, seven, one month and three months postoperatively.

RESULTS: With extremely significant intragroup differences (p = 0.001), the Study group showed a substantially quicker improvement in postoperative pain and edema than the Control group. In contrast to the Control group, which progressed more slowly, the Study group's healing scores increased more quickly, reaching exceptional healing by one month. Both groups had a considerable improvement in bone density, but the Study group saw a substantially larger amount of bone regeneration. Overall, the results show that the Study group had better results for both soft and hard tissue repair.

CONCLUSION: In comparison to the control group, the use of PRF considerably improved postoperative recovery within the study's constraints by decreasing pain and swelling and speeding up soft tissue repair and bone regeneration. Thus, in oral and maxillofacial surgery, PRF may be regarded as a dependable and efficient autologous adjuvant for enhancing both qualitative and quantitative healing results.

Key words – PRF, CBCT, Fracture, PRP.

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INTRODUCTION

Clinicians and other health care providers are extremely concerned about the alarming rise in quality of life, RTA, assaults, interpersonal violence, sports injuries, falls from heights, etc.[1]. These days, mandibular fractures rank among the most frequent maxillofacial injuries. Although traffic accidents and violent crimes are the principal factors of mandibular fractures, the correlation between these factors differs by nation[2]. Restoring of better relation of upper and lower teeth when opening and closing, restoring the form of the mandibular and facial arch, removing pain and infection, preventing internal temporomandibular joint derangement, and preventing mandibular growth disturbances are the objectives of mandibular fracture repair [3].

In today's era, there is an increasing demand for rapid treatment outcomes. Consequently, clinicians and researchers have focused on developing and investigating biomaterials that can enhance and accelerate the healing of mandibular fractures. One of the biggest problems arose during bio clinical research in creation of such materials that actively interact with biological tissue to enhance recuperation, promote tissue regeneration and reduce the risk of infection, so that it controls pain, swelling, chances of infections and speed up the recovery process. Numerous tools and methods have been created to improve and expedite the bone-healing process [4].

In the year 2006 Choukrouan and others discovered platelet rich fibrin(PRF) in france [5]. It is made without the use of gelifying additives or anticoagulants, it was recognised as a 2nd generation platelet concentrate [6]. PRF has a particular three-dimensional fibrin architecture and is entirely autogenous in nature. It is also simple and inexpensive. Furthermore, PRF has demonstrated elevated levels of certain growth factors and cytokines that affect soft tissue proliferation and bone regeneration [7].

It has been demonstrated that applying PRF to fracture sites, either by itself or in combined with fixation tools and grafting materials, improves soft tissue healing, speeds up bone regeneration, and lowers postoperative complications including infection and dehiscence. PRF offers a biological scaffold that promotes cell migration and improves fracture stability at the microscopic level and is autologous, affordable, and simple to create.

Improved radiographic bone density and more quickly functional recovery in PRF assisted mandibular fracture healing have been shown in recent clinical and experimental research. In order to optimize biological recovery, PRF is therefore a viable addition in modern maxillofacial trauma treatment.

This research was done in the IPD of Department of OMFS, which has highly developed equipment and high-class framework that are necessary for to treatment of the head and neck trauma and to determine the effectiveness of PRF in the healing of mandibular fracture, which was a clinical and cone beam CT study.

AIM AND OBJECTIVES

AIM: This comparative study was done to evaluate the efficacy of Platelet Rich Fibrin in mandibular fracture healing clinical and radiographic with miniplate fixation.

OBJECTIVES of the study were to:

1. Using CBCT, assess PRF's effect on healing of hard tissue (Bone) in the mandibular fracture.
2. To assess how PRF's effects on healing of soft tissue as well.
3. Assessment of discomfort and edema as post-operative sequelae following PRF's use.

INCLUSION CRITERIA

1. All healthy patients were selected as per ASA grade I & II.

2. Age group sixteen to fifty years and both male and female are taken.

3. Patients having mandibular fractures and need ORIF under General Anaesthesia/Local Anaesthesia.
4. The approved location for mandibular fractures were symphysis, Para symphysis, body and angle.
5. Patients should have sufficient number of teeth to achieve intraoperative pre-traumatic occlusion.

EXCLUSION CRITERIA

1. Patients with uncontrolled systemic disease and immunocompromised patients.

2. Patients with uncontrolled bleeding and clotting disorder.

3. Patients who are unable to keep follow up and poorly motivated.

METHODOLOGY

The patients were divided into 2 groups who underwent ORIF under GA/LA. Group A: -
(10 Patients) with placement of PRF on fracture site.
Group B: - (10 Patients) without placement of PRF on fracture site

A) Pre-Surgical Phase:

Every patient had a through history taken and then they were examined clinically and radiographically. In order to detect swelling, discoloration of the skin, soft tissue slashing, loss of blood, occlusal disturbances, discomfort, step deformities, mobility of fractured segments, precise fracture position and oral health, the clinical examination comprised both extraoral and intraoral examination of the fracture sites. Every patient had a radiographic evaluation at the time of admission. The number and location of fracture lines, location of inferior alveolar canal, and the presence of teeth within the fracture line were all determined by taking standardized presurgical cone beam computed tomography as well as panoramic radiograph.

B) Surgical Phase:

Strict aseptic protocol was followed during every single surgical procedure, which were done under GA as well as local anesthesia. Povidone iodine solution was used to disinfect the oral cavity and extraoral region. To achieve appropriate occlusion, maxillomandibular fixation was used momentarily. After the exposure of fracture line using intraoral approach, the broken segments were mobilized and if any soft or fibrous tissue is present between the fracture line, it was removed completely and then reduction was performed. Open reduction internal fixation was done by using standard titanium miniplates and screws. After confirming adequate fracture
reduction and stability fixation, this PRF was placed between the fracture segments and then closure was performed in layers using 3-0 polyglactin (Vicryl) sutures for internal tissues and 4-0 Ethilon or Prolene sutures for mucous or surface tissues.

Making of PRF:

Ten milliliters of the patient's venous blood were withdrawn and then transferred in two sterile 5 ml vacutainer tubes without anticoagulant. The samples were centrifuged at two thousand rpm for twenty minutes. After centrifugation was done, tubes were taken out from the centrifuge machine and look for resultant product. This process produced three distinct layers: PPP at the top, PRF in the middle and RBC at the bottom. The PRF then separated and cut out from Platelet Poor Plasma and RBC layers. After that it was gently compressed between two sterile glass slabs to form a PRF membrane and to expel the

excessive fluids. Then this PRF is placed between the fracture segment. (Fig. 1 to Fig. 8)

C) **Follow-up Phase:**

Follow-up was done all the week during the first surgical month and then at three months postsurgical. The examined points were soft tissue healing, pain, edema.

Finally, cone beam CT were executed preoperative, 1 months and at 3 months consequently to investigate:

1- The amount of the reduction of the fractured segment.

2- The effectiveness of the recovery process.

3- The average bone mineral density at the site of the fracture line.

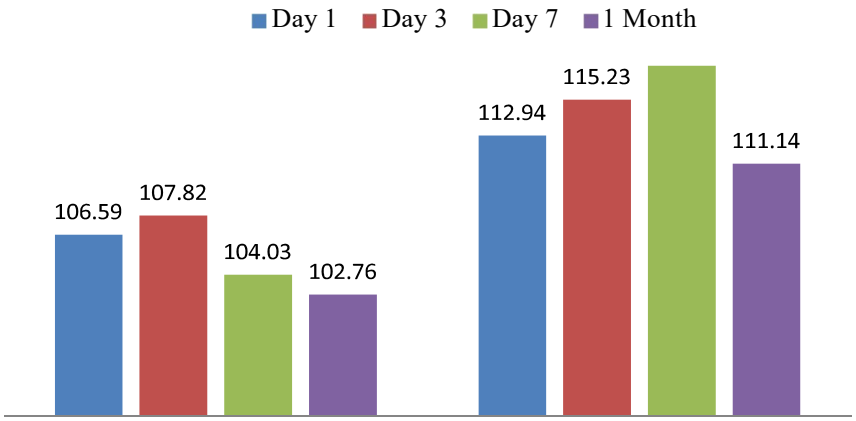
RESULTS AND OBSERVATION

(A) SWELLING

Time Interval	Study Group (Mean ± SD)	Control Group (Mean ± SD)
Day 1	106.59 ± 2.04	112.94 ± 5.82
Day 3	107.82 ± 1.82	115.23 ± 5.77
Day 7	104.03 ± 1.13	117.40 ± 6.46
1 Month	102.76 ± 1.36	111.14 ± 5.87

P value	**0.001**	**0.025**

Table : Overall facial swelling



Graph : Overall facial swelling

Both groups exhibited significant changes in swelling across time intervals. However, the Study group demonstrated an early reduction in swelling beginning from Day 7 onward, whereas the Control group showed a progressive increase up to Day 7 before partial resolution. These findings indicate that the Study group experienced a faster and more pronounced reduction in overall postoperative swelling compared to the Control group.

(B) PAIN

Time Interval	Study Group (Mean ± SD)	Control Group (Mean ± SD)
Day 1	6.90 ± 1.37	6.40 ± 1.17
Day 3	3.80 ± 0.79	4.30 ± 1.49
Day 7	1.50 ± 0.53	2.00 ± 1.05
P value	0.001	0.001

Table : Mean VAS score

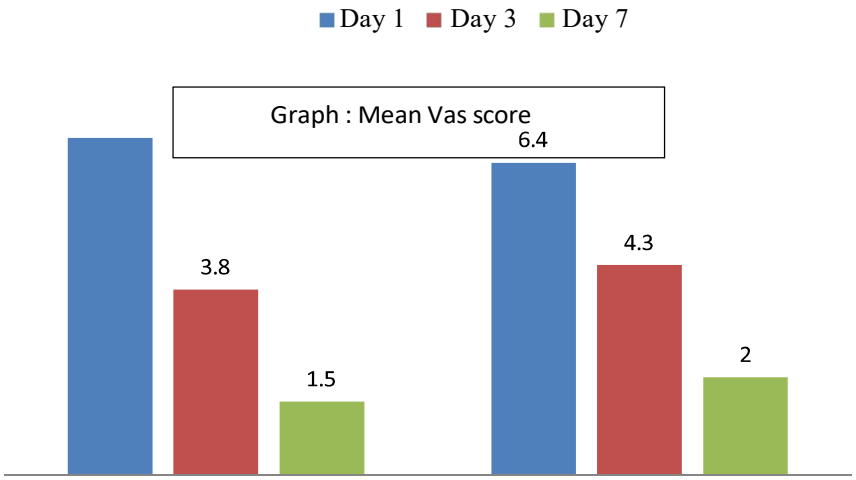


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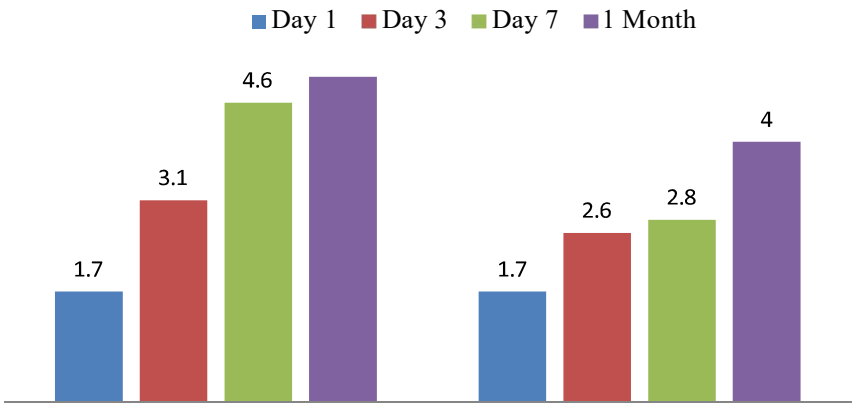
Table : Overall Healing Score

Both groups demonstrated a significant and progressive reduction in postoperative pain from Day 1 to Day 7. Although the Study group showed slightly lower pain scores by Day 7, intragroup analysis confirms that pain reduction over time was statistically significant in both groups, reflecting normal postoperative recovery with effective pain control.

(C) HEALING

Time Interval	**Study Group (Mean ± SD)**	**Control Group (Mean ± SD)**
Day 1	1.70 ± 0.48	1.70 ± 0.48
Day 3	3.10 ± 0.57	2.60 ± 0.52
Day 7	4.60 ± 0.52	2.80 ± 0.42
1 Month	5.00 ± 0.00	4.00 ± 0.82
P value	**0.001**	**0.001**



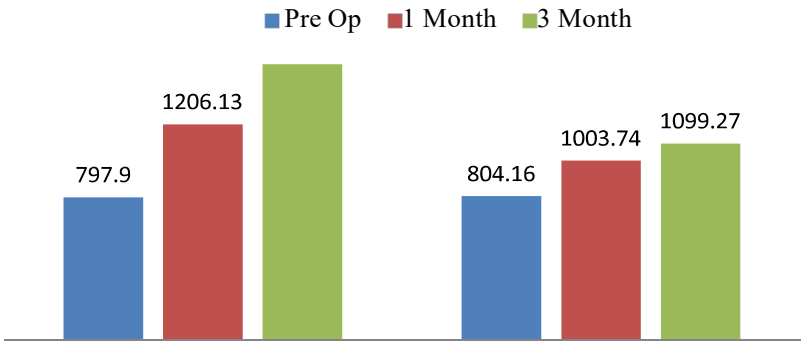
Graph : Overall healing score

Both groups demonstrated significant progressive improvement in healing over time. However, the Study group exhibited a more rapid and pronounced improvement achieving excellent healing by 1 Month, whereas the Control group showed slower progression and comparatively lower healing scores.

(D) BONE DENSITY

Time Interval	**Study Group (Mean ± SD)**	**Control Group (Mean ± SD)**
Pre Op	797.90 ± 77.38	804.16 ± 85.42
1 Month	1206.13 ± 146.84	1003.74 ± 85.71
3 Month	1544.61 ± 150.49	1099.27 ± 100.63
P value	0.001(Sig)	0.001(Sig)

Table : Overall bone density



Graph : Overall bone density

Although both groups showed significant improvement over time, the magnitude of increase was considerably greater in the Study group compared to the Control group, suggesting enhanced bone regeneration in the Study group during the healing period.

DISCUSSION

This study was conducted in OPD/IPD of Department of OMFS, TMDC&RC, Moradabad, Uttar Pradesh to examine the efficacy of PRF in healing of fracture of the mandible: a Clinical & cone beam computed tomographic Study. A sum of 20 patients was registered in this study and randomly alloted to Group A (Study Group)-who received PRF in mandibular fracture and Group B (Control Group)-who did not received PRF. The following discussions evaluates the outcomes observed in Study and Control group.

Compared to the non-PRF group, our study measured the surgical phase of postoperative swelling, pain, the soft tissue healing and the bone density in the healing process of mandibular fracture. Although within-group analysis showed statistically noticeable differences among both groups, the parameters measured were greater and more consistent among the experimental group compared to the control group, and complications were less than expected. In previous studies conducted with regard to the utilize of autologous platelet concentrates, such as PRF, our data supports the use of these interventions to promote the healing response associated with the healing process.

Post-Operative Swelling

Post-operative swelling after a surgical procedure is a common observation that is experienced primarily due to acute vascular dilation, increased permeability at the capillary level, and the exudation of plasma proteins from the vascular system into the interstitial spaces. The result of the current study showed that there were significant differences between the 2 groups over time, and it was also observed that the pattern of resolution of swelling in both groups was statistically significant.

In the PRF group, there was a noticeable decrease in swelling from Day 1 to Day 7, and it was almost resolved by 1 month postoperatively. Conversely, in the control group, swelling was consistently increased from Day 1 to Day 7 and gradually decreased from Day 7 to 1 month but remained more prominent as compared to the study group.

The reason for the faster reduction of edema in the study group may be due to the biological characteristics of PRF. The fibrin matrix of PRF has the growth factors, leukocytes, and platelets, allowing for the steady release of the cytokines PDGF, TGF-β, and VEGF. Choukroun et al. (2006)[8] state that these mediators induce the inflammatory responses, start angiogenesis, and help in early stages of tissue remodelling. Researcher observed that the there is reduction in swelling in study group might be the reason of anti-inflammatory action of PRF. According to Toffler (2009)[9], PRF helps in lymphatic drainage and regulates inflammatory mediators to minimize the incidence of postsurgical swelling. One more, Dohan Ehrenfest and others (2010)[10] showed that the fibrin matrix of PRF helps in clearing inflammatory exudates by giving a scaffolding for cellular movement. These findings of this study are consistent with other studies indicating that PRF improve early healing and significantly decreases postsurgical edema.

Pain

Pain is an unpleasant response, and chemical messengers such as PG's, bradykinin, and substance P are some of these substances that conciliate the pain experience. In our study there were statistically noticeable reductions in Visual Analogue Scale (VAS) ratings calculated from first day to one week in PRF groups in contrast to the non-PRF group. However, mean pain ratings in the study group at all postoperative periods were less than those of the control group. It appears that the biological function of platelet-rich fibrin (PRF) could be related to early pain reduction in the study group. The growth factors and cytokines that are released over an extended time enhance the soft tissue coverage and decrease the chance of exposure of nerve endings. Additionally, the leukocytes in PRF may change the inflammatory cascade and then decrease nociceptive stimulation.

The administration of PRF at oral surgical sites significantly decreases postoperative pain by enhancing early wound stability, as noted by Simonpieri with others (2012)[11]. Similarly, Kumar with others (2015)[12] noted that sockets treated with PRF following tooth extraction had lower VAS ratings than sockets that were not treated with PRF.In addition, the fibrin

matrix of PRF can provide a barrier to infection and mechanical irritation at the surgical site, which may further reduce pain. The significantly faster reduction in pain in the study group, even though both groups essentially healed normally, indicates greater patient comfort and a higher level of healing quality.

Healing of Soft Tissue

The Healing Index revealed an extremely radically difference between both study and control groups. Specifically, within the study group, by Day 7 after treatment, each participant had experienced "very good" recovery rates, and by the end of the 30-day period, they had all experienced "excellent" recovery levels. In contrast, the control group had slower rates of recovery than the study group and by 30 days had only achieved "very good" levels of recovery. Four stages of healing occur in the healing of soft tissue (hemostasis, inflammatory, proliferative, and remodeling); all four stages are enhanced with the aid of PRF. Platelets will become confined in the fibrin matrix and release GF essential for the synthesis of collagen and growth of fibroblasts, while the fibrin matrix will provide a stable structure. According to Dohan Ehrenfest et al. (2009)**[10],** some growth factors like TGF, VEGF, FGF etc are derived from PRF which promotes epithelialization with angiogenesis. Choukran et al. (2006)**[8]** also found that the employ of PRF enhanced the healing of muco-gingival tissues. This may explain why the PRF group had excellent healing indices than non-PRF group, as better deposition of extracellular matrix, high levels of fibroblast activity, and enhanced angiogenesis were found. Because there are no anticoagulants used with PRF, fibrin polymerizes naturally to create a strong and pliable matrix that supports the healing of tissue. These findings further support previous research demonstrating that PRF significantly enhances soft tissue healing after oral and maxillofacial surgical procedures.

Bone density

Bone density is a complex sequence of bone repair components that are necessary for full bone restoration. The study and control groups in this research demonstrate statistically significant increases in bone density via measurements taken prior to surgery in comparison to three-month assessment dates. Moreover, however, the study group had an increased level of improvement in bone density. After three months, the study group's average bone density increased by more than 746.0 Hounsfield Units (HU) from 798.0 HU pre-surgery to 1544.0 HU post-surgery, while the control group had a net increase of 295.0 HU from 804.0 pre-surgery to 1099.0 post-surgery. Thus, a notable difference seen between the PRF group and the placebo group regarding bone density as well as the amount of bone regenerated. The study group improved Hounsfield Unit results in 3 months, for mineralization and trabecular structure of bone indicate the potential to decrease healing times following surgical procedures that improve bone regeneration by enhancing the clinical outcome.

In addition to demonstrating enhanced bone density early after surgery, the significantly higher bone density values seen in the PRF group at three months also support that PRF has osteoinductive (producing new bone) and osteoconductive (supporting the growth of new bone) properties, as evidenced by the pioneering research conducted by Robert E. Marx**[13]** regarding platelet concentrates and further observed clinically by Simonpieri et al. According to Simonpieri et al. (2011)**[11],** the ability of PRF to enhance bone density and maturation was supported in research involving the use of PRF in both grafting and implant placement procedures. The use of PRF is also believed to accelerate osseointegration, as evidenced by increased bone density from CBCT measurements.

There are four ways how PRF greatly aids in improving the healing of bone tissue:

1. Release of osteogenic growth factors (for example, PDGF, TGF-Beta)
2. Promotion of VEGF-mediated angiogenesis
3. Recruitment and proliferation of osteoblast progenitor cells
4. Formation of a fibrin scaffold to enhance the ability of the mineral deposit process to occur

Research done by Zhang with others in 2012 to appraise the impact of PRF on new bone formation in sinus augmentation procedure. Their results showed that cases in which PRF was used demonstrated 1.4 times greater new bone formation compared to control group. These findings are similiar with our study, in which we also observed increased new bone formation in mandibular fracture cases where PRF was applied. Dulgeroglu[14] in his 2017 study, stated that PRF accelerate the bony tissue formation and is highly effective in fracture healing. His findings are consistent with our study, as we also observed similar results demonstrating improved bone formation in cases where PRF was used. Cieslik-Bielecka et al in 2008, evaluated bone mineral density after eliminate of odontogenic cyst from the mandible, after that PRF gel was placed at the defect site. Their results showed a consistent increase in bone density at both 3 months and 6 months postoperatively in accordance to our result.

Our study on the use of PRF with healing mandibular fractures agrees with the work of AI Rayess et al.[15], who found that the average density of bone was constantly higher for the PRF group than for the controls. AI Khawlani[16] et al. studied the effectiveness of using PRP and PRF on the healing of mandibular fractures. Their results suggest that PRP and PRF both accelerate the rates of bone healing, but that PRF is superior to PRP for increasing the amount of bone that is formed.

But in our study group, there was a 19-year-old male with a fractured mandible. A mini-plate fixation was accomplished, and PRF was applied to the fracture site. The initial postoperative swelling was appropriate. After approximately 5 months there was pronounced swelling of the left side at the site of the fracture (Fig. 9), and a secondary surgical procedure for plate removal was scheduled (Fig. 10). During surgery it was noted that there was a significant amount of new bone growth around the area of the fracture, which was attributed to an augmentative osteogenic reaction possibly due to the interaction between PRF and the subperiosteal soft tissues, resulting in enhanced periosteal stimulation and improved osteogenesis by enhancing the deposition of bony tissue.

CONCLUSION

In conclusion, the present research clearly demonstrates that compared to the placebo group, the application of Platelet-Rich Fibrin (PRF) increases recovery after a procedure primarily due to reductions of edema, pain relief, tissue repair, and new bone formation. Evidence for the quickness of pain relief and reduction of swelling (edema) in the PRF group indicates that PRF possesses a significant degree of immunomodulatory and anti-inflammatory effects. GF continuously emancipate from the fibrin matrix such as PDGF, TGF-β, and VEGF seem to facilitate angiogenesis (new blood vessel formation), fibroblasts proliferation (cells that will eventually form connective tissue), and epithelialization (new skin formation). All of these cellular activities will enhance the healing process of soft tissue. Not only soft tissue healing, PRF also promote earlier production of new bone with enhances the excellent of mature and latest bone formation, as evidenced by the increased degrees of mineralization and trabecular maturation noted on CBCT imaging. Therefore, PRF can be classified as an autologous, physiologically active adjunct, that enhances the healing process in both qualitative and quantitative ways and should be considered a reliable and clinically beneficial therapeutic modality of treatment.

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Illustrations

Fig. 2: Transfer of venous blood into vacutainer

Fig. 7: PRF placed on the fracture site

Fig. 8: Wound closure was done using 3-0 Mersilk

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Illustrations

Fig. 10: Post operative photo after 1 year

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