



A Study of Functional Outcome of Platelet-Rich Plasma (PRP) Infiltration in Delayed Union of Long Bones

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Abstract

Background: Delayed union of long-bone fractures remains a challenging problem in orthopaedic practice. Platelet-rich plasma (PRP), containing concentrated platelets and growth factors, may enhance the biological process of fracture healing.

Aim: To evaluate the radiological outcome of local PRP infiltration in patients with delayed union of long-bone fractures.

Methods: This study was conducted at Kempegowda Institute of Medical Sciences, Bangalore. Patients aged 18–65 years with clinical and radiological evidence of delayed union five months after initial surgery were included. Patients received three local PRP infiltrations at four-week intervals. PRP was prepared on the day of the procedure and injected into the fracture cleft under local anaesthesia with C-arm guidance. Radiological healing was assessed using the Modified Radiographic Union Score (mRUST) on follow-up radiographs.

Results: At six months of follow-up, **84% of patients demonstrated satisfactory radiological union** according to the Modified RUST score. Delayed union was most frequently observed in middle-third femoral shaft fractures, followed by distal tibial fractures.

Conclusion: Local PRP infiltration appears to be a promising adjunctive treatment for delayed union of long-bone fractures. Further controlled studies with larger sample sizes and validated functional outcome measures are required to confirm its effectiveness.

Keywords: Platelet-rich plasma; Delayed union; Long-bone fractures; Fracture healing; Modified RUST score; Orthopaedic trauma.

INTRODUCTION

Delayed union is a condition in which a fracture fails to demonstrate satisfactory progression toward union within the expected period of healing. Long-bone fractures, particularly those involving the femoral shaft and tibia, may be complicated by delayed healing because of biological, vascular and mechanical factors. Management generally aims to address mechanical stability and enhance the biological environment at the fracture site.

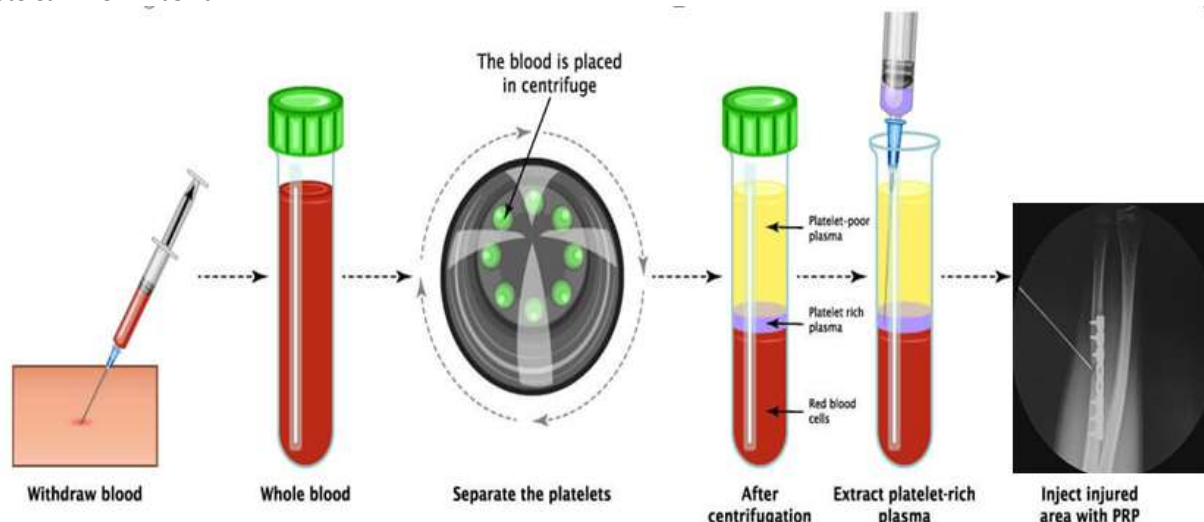
Platelet-rich plasma (PRP) is an autologous blood-derived preparation containing a high concentration of platelets and various growth factors. These growth factors may contribute to angiogenesis, cellular proliferation, extracellular matrix formation and tissue repair, thereby potentially promoting fracture healing. Because of these biological properties, PRP has been investigated as an adjunctive treatment in delayed union and non-union of fractures.

Radiological assessment is an important component in evaluating fracture healing. The Modified Radiographic Union Score (mRUST) assesses the four cortices on anteroposterior and lateral radiographs based on fracture-line visibility and callus formation. It provides a structured method for monitoring progression toward radiological union.

The present study was undertaken to evaluate the radiological outcome of **local PRP infiltration in patients with delayed union of long-bone fractures**, using the Modified RUST scoring system following three PRP infiltrations administered at four-week intervals.

It is present when an adequate period of time has elapsed since the initial injury without achieving bone union. Average healing time of long bone shaft fractures is 6-9 months.

Platelet - Rich Plasma



METHODOLOGY

The study was conducted in KEMPEGOWDA INSTITUTE AND MEDICAL SCIENCE, BANGALORE.

Detailed history and demographic details was collected from the patients.

All patients underwent routine blood investigations and standard AP and Lateral Views were used to evaluate the patients.

Written informed consent were taken from each patients.

The radiological outcome after PRP infiltration were assessed.

The patient were given 3 infiltration in a gap of 4 weeks.

In our study PRP was prepared on the day of surgery and infiltration was given under local anesthesia under the guidance of C-ARM in the operation theatre.

Criteria's

Inclusion Criteria

- Patients aged between 18 – 65 years
- Patients of both sex
- Patients who had clinical and radiological signs of delayed union at the end of 5 months after the initial surgery

Exclusion Criteria

- Patients aged under 18 years
- Patients with pathological fractures
- Patients established non-union

Modified RUS Score

The mRUS Score evaluates fracture healing in long bones using AP and Lateral x-rays

We assess each of 4 cortex:

1. Anterior Cortex
2. Posterior Cortex
3. Medial Cortex
4. Lateral Cortex

Each Cortex is scored 1 to 4, based on fracture line visibility and callus

Score		
1.	Fracture line visible	No Callus
2.	Fracture line visible	Callus Present
3.	Fracture line still visible	Bridging Callus
4.	Fracture line not visible	Bridging callus



Post op X-ray



06 months post infiltration X-ray

RESULTS

In our study we used Modified RUS Scoring, which is based on the visibility of fracture line and presence or absence of callus on plain radiographs after a period of six months from the initial infiltration of PRP.

In our study we discovered that patients who underwent PRP infiltration three times, four weeks apart and were followed up with x-rays after six months had outstanding union results according to Modified RUST Score of 84% which is consistent with other studies.

The study evaluated the outcome of three local PRP infiltrations given four weeks apart in patients with delayed union of long-bone fractures. At six months, **84% of patients achieved satisfactory radiological union** according to the Modified RUST (mRUST) score. The most frequently affected sites were the **middle-third femoral shaft** and **distal tibia**.

Table 1. Modified RUST (mRUST) scoring system

Score per cortex	Radiological finding
1	Fracture line visible; no callus
2	Fracture line visible; callus present
3	Fracture line visible; bridging callus present
4	Fracture line not visible; bridging callus present

The mRUST score assesses four cortices on AP and lateral radiographs, with a total possible score of 4–16. Higher scores indicate greater progression towards union. The score has been shown to provide a reliable quantitative assessment of fracture healing.

Table 2. Summary of study outcome

Parameter	Finding
PRP treatment	3 infiltrations, 4 weeks apart
Follow-up	6 months
Primary radiological assessment	Modified RUST score
Satisfactory union	84%
Most frequently affected site	Middle-third femoral shaft
Other frequent site	Distal tibia
PRP administration	Local injection into fracture cleft under C-arm guidance

The present study was conducted to evaluate the functional and radiological outcome of local platelet-rich plasma (PRP) infiltration in patients with delayed union of long-bone fractures. Patients fulfilling the predefined inclusion and exclusion criteria were treated with three PRP infiltrations at four-week intervals and were followed clinically and radiologically for six months following the final/initial infiltration, as per the study protocol.

Demographic Characteristics

A total of [insert total number] patients with delayed union of long-bone fractures were included in the study. The study population consisted of [insert number] males and [insert number] females, with an age range of 18–65 years. The mean age of the study population was [insert mean $\pm$ SD] years.

Distribution According to the Fracture Site

Delayed union was observed in fractures involving different long bones. The highest proportion of delayed unions was observed in **femoral shaft fractures, particularly middle-third fractures**, followed by **distal tibial fractures**.

Among the femoral shaft fractures, delayed union was predominantly observed following fixation with **intramedullary nailing**, whereas distal tibial delayed unions were observed following operative fixation with **plates and screws**.

The distribution of patients according to the fractured bone, fracture location and method of fixation is shown in Table [X].

Radiological Assessment

Radiological assessment of fracture healing was performed using the **Modified Radiographic Union Score for Tibia (mRUST)**/Modified RUST scoring system. The four cortices were assessed on anteroposterior and lateral radiographs based on the visibility of the fracture line and the presence and extent of bridging callus.

Each cortex was assigned a score from 1 to 4:

- **Score 1:** Fracture line visible with no callus
- **Score 2:** Fracture line visible with callus formation
- **Score 3:** Fracture line still visible with bridging callus
- **Score 4:** Fracture line not visible with bridging callus

The total mRUST score therefore provided an objective radiological assessment of progression towards fracture union.

Radiological Outcome Following PRP Infiltration

Patients received **three local PRP infiltrations at four-week intervals**. PRP was prepared on the day of the procedure and injected into the fracture cleft under local anaesthesia with C-arm guidance.

At six months of follow-up, radiological evidence of satisfactory fracture healing was observed in **84% of patients** according to the Modified RUST scoring system.

The majority of patients demonstrated progressive callus formation, reduction in fracture-line visibility and cortical bridging on follow-up radiographs. Patients with favourable radiological progression showed improvement in the mRUST score during serial follow-up.

The highest proportion of satisfactory union was observed among patients with **middle-third femoral shaft delayed unions**.

Overall Outcome

Overall, the study demonstrated a favourable radiological response following local PRP infiltration in patients with delayed union of long-bone fractures. Three PRP infiltrations administered at four-week intervals were associated with radiological evidence of union in **84% of the study population at six months of follow-up**.

CONCLUSION

Platelet rich plasma growth factors infiltrated locally are effective in the treatment of delayed union of long bone fractures.

The highest incidence of delayed bone union was seen after surgical treatment of femur shaft middle 1/3rd fractures and distal tibial fractures by closed reduction and intramedullary nail fixation and plate and screws.

Infiltration of PRP into the fracture cleft was most effective in the patients with bone union disturbances after middle

1/3rd femur shaft fractures.

PRP infiltrated locally is effective in the treatment of delayed union of long bone fractures.

DISCUSSION

The present study found **84% satisfactory radiological union at six months** following three local PRP infiltrations at four-week intervals in patients with delayed union of long-bone fractures. The most frequently involved sites were the middle-third femoral shaft and distal tibia.

PRP contains concentrated platelets that release growth factors involved in angiogenesis, cellular proliferation and tissue repair. These biological effects may provide additional stimulation at a fracture site with delayed healing. Evidence from a systematic review and meta-analysis suggests that PRP may improve healing rates in long-bone delayed union/nonunion, although results vary among studies. A more recent umbrella meta-analysis also found a possible benefit in healing rate and healing time, while noting uncertainty in individual-study pooled results and no clear improvement in functional outcomes.

The 84% union observed in the present study is broadly comparable with previously reported PRP outcomes, but it should not be interpreted as definitive evidence of treatment efficacy because the present study has no control group. Natural progression of healing, mechanical stability, fixation method and rehabilitation may also have contributed to the observed outcome.

The Modified RUST score was used to assess radiological progression. It evaluates four cortices and provides a quantitative measure of callus formation and fracture-line disappearance. Previous studies have demonstrated reasonable reliability of mRUST and have established its usefulness in assessing fracture healing.

The predominance of delayed union in middle-third femoral shaft and distal tibial fractures may reflect differences in fracture biology, soft-tissue condition, vascularity and mechanical environment. PRP may be most useful as an adjunct when adequate mechanical stability is already present but biological progression remains unsatisfactory.

The major limitation of the present study is the absence of a comparison group and the limited information on functional outcome. Therefore, although the findings are encouraging, PRP should be considered a potential adjunct rather than a proven replacement for established treatment of delayed union. Larger controlled studies with standardised PRP preparation, validated functional scores and longer follow-up are warranted.

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