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Original Research Article

Effectiveness of Platelet Rich Plasma as an Adjuvant for Union in Humerus Shaft Fractures Treated Surgically

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Abstract

Background: Humerus fractures accounts for 3-5% of all fractures and diaphyseal fractures account for 30% of all humerus fractures. There are various treatment options from conservative treatment to different surgical fixations. The incidence of Non-union is 2-10% in conservatively treated fractures and 13% in surgically treated fractures. The ability of PRP in providing huge amount of growth factors stimulates tissue regeneration and healing process. This present study aims at studying effect of PRP on bone union and functional outcome of humerus shaft fractures treated surgically.

Materials and methods: 20 patients with humerus shaft fracture after following inclusion and exclusion criteria were enrolled in this prospective non randomised study. All the patients received 5ml of PRP injection at the fracture site after internal fixation weather open or closed reduction is performed. The patients were followed up and evaluated for radiological union and Neer's functional score[1] at end of 1st month, 3rd month and 6th month.

Results: This study included 20 cases treated surgically. Out of which 70% were males and 30% females, with mean age being 40.58 yrs. Most involved side being right side. Mode of injury is RTA in 80% and self-fall in 20% none due to assault. Plating was done in 85% and nailing in 15%. 83% of patients achieved union by end of 3rd month probably due to PRP and 90% achieved excellent outcome by end of 6 months.

Conclusion: The statistical improvement in p value for all components in Neer's scoring system indicates there is some positive effect of PRP on pain relief, range of motion and functional outcome when used as adjuvant in fracture fixation.

Keywords: Platelet rich plasma (PRP), Humerus fractures, Neer's score.

Introduction

Humerus shaft fractures account for 3-5% of all fractures and 30% of humerus fractures are diaphyseal fractures. Historically non operative treatment used to the choice of treatment for many

humerus fractures. However, to improve clinical outcome and to allow early range of motion internal fixation was chosen. Nonunion rate is 3-10% in non-operatively treated fractures and 13% in surgically treated fractures. Nonunion in humerus shaft fractures is multi factorial even with the best efforts certain percent of fractures may go into non-union.

In 1990's PRP was first used in oral maxillofacial surgery and successful in demonstrating increase in mandibular bone density. PRP can be easily collected from the patients own blood. The concentration of growth factors is 8 times higher than in blood which facilitates wound healing and bone repair. The application of PRP is newer method in promoting bone healing through growth factors in platelets.[2]

Platelet rich plasma (PRP) includes vascular endothelial growth factor (VEGF), platelet derived growth factor (PDGF), Transforming growth factor beta(TGF-B), insulin like growth factor (IGF1, IGF 2), fibroblast growth factor (FGF), hepatocytic growth factor, interleukin-8 and matrix metalloproteinases.[3,4] These huge amount of growth factors in PRP stimulates neovascularization therefore increase of blood supply. It also stimulates proliferation and differentiation of mesenchymal cells which are involved in bone healing.[5]

PRP for treatment of delayed and non-unions has been documented. use of PRP along with other adjuvants like autografts and allografts is also tried.[2] But role of PRP in acute fractures is still controversial. This present study aims to evaluate role of PRP in fracture healing of humerus shaft fractures.

Materials and methods

This is a prospective non randomized study done at Kamineni institute of medical sciences, Narketpally. 20 patients who sustained humerus shaft fracture and were admitted between October 2019 - September 2021 were enrolled in this study after satisfying inclusion and exclusion criteria.

Inclusion criteria:

1. All the patients with humerus fracture managed surgically.
2. Age 18 - 70 yrs.
3. Patients of both sexes.
4. Patients with normal ESR and Platelet count > 2.5 lakh

Exclusion criteria:

1. Patient with platelet count of < 2.5 lakhs.
2. Patients sustained Pathological fractures.
3. Patients with age of < 18 years and > 70 years.
4. Patients who were lost to follow-up.
5. Patients with radial nerve palsy.

This study was conducted after taking clearance from intuitional ethics committee and informed consent from the patient.

PRP preparation:

35-40 ml of venous blood is collected and 5ml of acid citrate dextrose solution was added to it. Two spin technique was followed. First spin for 15 min at 1600 rpm and top two layers collected leaving the bottom RBCs. the plasma and buffy coat layers are again centrifuged for 7 min at 2800 rpm. Top layer is platelet poor plasma and bottom layer is platelet rich plasma.

After reduction of fracture by closed or open method fixation is done by either plating or intramedullary nailing. The freshly prepared PRP is taken in a sterile syringe and infiltrated at the fracture site. No drain was placed and wound is closed in layers.[6]

Patient was followed at end of 1 month, 3 months and 6 months. Radiological union of the fracture and functional outcome according to Neer's scoring system was documented at each visit.

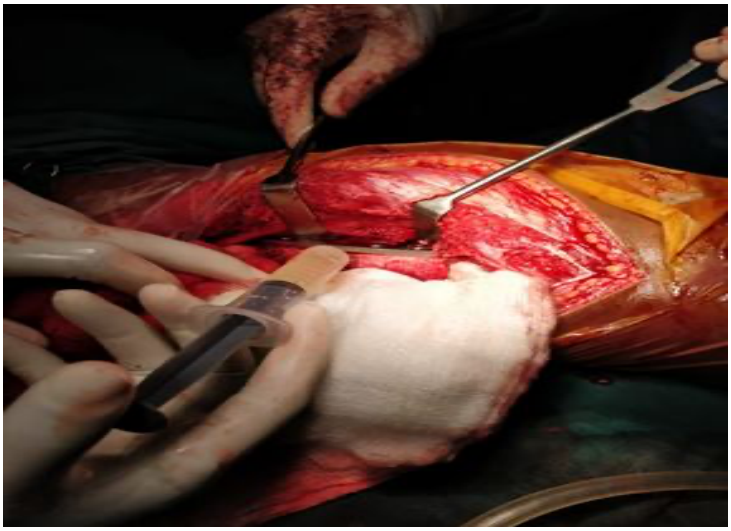

Figure 1: showing infiltration of fracture site with PRP

Results:

This study included 20 cases who were treated surgically and given PRP injection a fracture site. Among them 14(70%) were males and 6(30%) were females. Most of them belong to 30-40yrs age group with mean age of 40.58 yrs. Right side (70%) being more common than left. Majority of them sustained injury due to RTA (80%) followed by self-fall (20%). No injuries due to assault. 17(85%) patients were treated with open reduction and plating. 3(15%) patients were treated with closed reduction and nailing. 80% of patients had union by end of 3 months and 90% had excellent functional outcome by end of 6 months.

Table 1: Average Neer's Scoring at all 3 Visits (N=20)

	Average Neer's Score		
Component of Neer's Score	1st month follow up	3rd month follow up	6th month follow up
Functional Outcome (30)	16.42	23.25	28.50
Range of Motion (25)	11.08	19.75	23.75
Pain (35)	19.58	28.75	33.75
Radiological Anatomy (10)	9.6	9.6	9.6
Total (100)	56.68	81.35	95.6

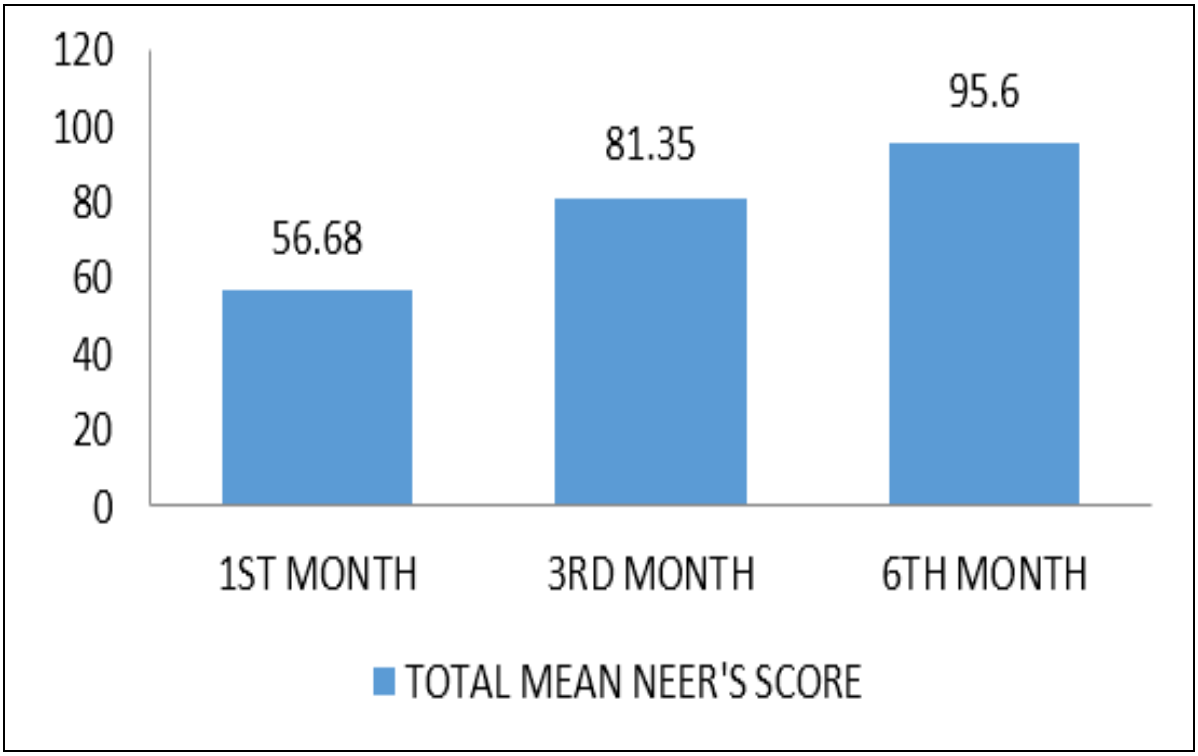

Figure 2: Average Neer's Score at all 3 Visits

The above table and graph show gradual increase in the average Neer's score from 1st and 3rd to 6th month. More the average score suggests better the outcome of the patient (functional, range of motion, pain tolerance and radiological anatomy findings.)

Table 2: Functional outcome based on Neer's scoring system (n=20)

Neer's Score	Excellent	Satisfactory	Unsatisfactory	Failure	Total
Outcome	18	2	0	0	20

In the current study out of 20 cases, 18(90%) cases had excellent functional outcome and 2(10%) cases had satisfactory functional outcome when assessed with Neer's scoring system with this data it is possible to say that PRP infiltration at fracture site at the time of surgery has helped in excellent functional outcome in humerus fracture patients, in majority of cases.

Table 3: Time of Radiological Union after PRP Injection (n=20)

S. No.	Procedure with Prp Injection	1 month	3 months	6 months
1.	**Or if + Plating with Prp Injection**	none	15	2
2.	**im Nailing with Prp Injection**	none	2	1

In current study out of 20 cases 17(85%) cases were managed with ORIF + Plating with PRP injection and 3(15%) cases were managed with Closed reduction+IM nailing with PRP injection and followed up for 6 months and evaluated radiologically with serial radiographs. In plating with PRP group out of 17 cases 15(88.2%) cases achieved union by end of 3 months. In nailing with PRP group out of 3(15%) 2 patients (66.6%) achieved union by end of 3 months, with this data it is possible to say that PRP injection at fracture site at the time of surgery has helped in reducing the time of fracture union.

Though complications like; neurological injury, wound dehiscence, infection, non-union or delayed union are described in literature, in the present study no

complications were noted during the period of follow up.

Discussion

Humerus fractures accounts for 3-5% of all fractures. Treatment by nonoperative methods were being replaced by internal fixation techniques for better outcome and early range of motion. The non-union rate in surgically treated humerus fractures is 13% when compared to conservative treatment which is 2-10%. There are various internal fixation methods like plating and nailing with both having their merits and demerits. despite of best efforts some percent of fractures goes to delayed and non-unions. There is a constant endeavor by surgeons to prevent this situation.

PRP which is rich in several growth factors showed promising results in tissue regeneration delayed unions and non-unions PRP have many growth factors like transforming growth factor-beta (TGF-ßs), platelet-derived growth factors (PDGF), insulin-like growth factor (IGF), vascular endothelial growth factors (VEGF), and fibroblast growth factor-2 (FGF-2). TGF-ß1 stimulates secretion of extracellular matrix, including collagen. TGF-ß1, IGF-1, and PDGF stimulates proliferation and differentiation of mesenchymal cells. [3,4]

Many new modalities of treatment including PRP are under research to promote bone regeneration. PRP had shown to stimulate osteoblast proliferation in vitro and to enhance bone repair, presumably because of the high levels of autologous growth factors. PRP when supplemented with fibrin glue turns to a platelet gel which helps confine growth factor secretion to a chosen site. Another advantage of PRP is its versatility, that is, it permits local delivery of growth factors non-operatively by infiltrating the fracture site with activated platelet rich plasma. The present study aimed to evaluate the role of PRP in biologic enhancement of healing in humerus shaft fractures radiologically and functionally.[7]

The use of PRP in various clinical settings has been well documented.

Ravish VN et al (2019) Platelet rich plasma infiltrated locally is effective in the treatment of delayed union of long bone fractures, PRP Infiltrated into the fracture cleft was most effective in the patients with bone union disturbances after middle 1/3rd femur shaft fractures.[8]

Mario lenza et al (2013) study showed that there is no conclusive evidence to prove that the use of PRP as a coadjuvant aids in the bone consolidation of fractures, pseudoarthrosis, or bone defects. There is need for well organised RCT's, with adequate sample size and high statistical power to investigate the effectiveness of PRP use as a coadjuvant in bone regeneration.[3]

Roop Singh et al (2017) conducted a study to evaluate the role of platelet-rich plasma treatment of acute diaphyseal fractures of the femur and concluded that PRP has no effect on femoral shaft fracture healing treated with closed intramedullary nailing. However, PRP may provide an artificial hematoma effect in the initial phase of healing in open or failed closed intramedullary nailing.[7]

The present study was conducted on 20 patients with shaft humerus fractures who were admitted in Kamineni institute of medical sciences (KIMS) from October 2019 to September 2021. Assessment of improvement in pain, functional outcome, anatomy and range of motion after intraoperative PRP infiltration at fracture site patient was followed up for 6 months and parameters evaluated by using NEER'S Scoring System with each component given a score as 35 for pain, 30 for function, 25 for range of motion and 10 for anatomy all in total 100. A score of >89 means excellent, 80-89 satisfactory, 70 - 79 unsatisfactory, <70 failure.

In our study period of follow up was done for total of 6 months as interval of 1st, 3rd and 6th month. On reviewing the literature, it is seen that in the study conducted by Roop singh et al (2017) , and study by Ravish VN et al (2019) the follow up period was 6 months; In present study though the follow up period is 6 months, the fracture united much earlier both clinically and radiologically.

In our study average time of radiological fracture union is 3rd month follow-up. On reviewing the literature, it is seen that the average union time of fracture in various studies as follows Ravish VN et al (2019) had done platelet rich plasma infiltration at fracture site and average union achieved by 4th month;[8] whereas in the study by Roop Singh et al (2017) they had infiltrated platelet rich plasma in femur shaft fractures and compared study with and without PRP infiltration and achieved union by 4 months in most of cases but concluded that platelet rich plasma may not have a very much significant role in bone healing.[7]

In current study out of 20 cases open reduction and plating was done for 17(85%) cases and closed reduction and nailing for 3(15%) cases with infiltration of platelet rich plasma at fracture site at the end of surgery cases and fracture union achieved in patient with plating by 12 weeks and union achieved in nailing patients by 16 weeks hence union is faster in plating group with platelet rich plasma when compared to nailing group. S. Ghosh et al (2013) conducted a study to evaluate the humerus fracture union time in both open reduction with plating and closed reduction with nailing without any adjuvant and union was achieved and they concluded that fracture managed with plating has tendency of early union when compared to intramedullary nailing.[9]

In the study carried out by Soumya Ghosh et al. (2013)[9] on 60 patients with acute humeral shaft fracture. They found that 86.6% of patients of plating group had excellent functional outcome. However, in present study Overall functional outcome as per NEER'S scoring system in 90% of cases it is excellent and remaining scores are satisfactory.

In the present study of 20 patients no patient had any complications like infection, non-union, delayed union. Roop Singh et al (2017) has conducted the study to assess the role of PRP infiltration in acute femur shaft fracture and there were no complications like infections in any of patients.[7]

Limitations:

1. Sample size in the present study is only 20
2. There is no comparative group in our study.
3. Quantitative/Qualitative analysis of platelet rich plasma was not done prior to infiltration.
4. Leucofilter were not used in the present study.

There were no studies found on review of literature where in surgical management of fracture of humerus were carried out along with local infiltration of platelet rich plasma at the end of surgery; to assess fracture healing rates. therefore, this study in unique in this aspect; though this study has limitations.

Conclusion

Platelet Rich Plasma has evolved as a new modality of adjuvant treatment to promote bone regeneration. The present study demonstrates the positive effect of Platelet Rich Plasma on humerus bone healing, radiological union and good functional outcome. Hence, it can be safely recommended as an adjuvant to surgical treatment of fracture of humerus.

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