Original Article

Surgical fixation and grafting of traumatic distal tibia atrophic nonunion with or without platelet-rich plasma: A comparative study

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Objective: To compare distal tibia nonunion plating and grafting with and without platelet-rich plasma (PRP) regarding union rate, union time and complications

Methodology: In this prospective comparative study, 32 patients with nonunion tibia from July 2017 January 2019 were divided into two groups: group A (16 cases) were treated by plating and grafting with PRP and group B (16 cases) were treated by plating and grafting only.

Results: There was higher union rate in group A related to group B (81% vs. 69%) but statistically not significant (p=0.256). Healing duration was significantly longer in group B (6.11 vs. 5.12) months(p=0.001). Regarding the postoperative pain, it was significantly less in groups A than group B.

Conclusion: Combining PRP with autologous bone graft results in a higher union rate, less healing duration, less post-operative pain, and more callus formation. (Rawal Med J 202;45:629-632).

Keywords: Tibial nonunion, bone graft, platelet-rich plasma.

INTRODUCTION

Fractures of the tibia are seen in 4% of all fractures and relatively high rates of nonunion and malunion.[1] The lower third of the tibial shaft is common site for fracture and about 25% are open type. The best management remains a matter of dispute, and in many states, there may be no solitary "best" management, depending on the "personality" of the fracture.[2] Nonunion of the tibia are not unusual due to the subcutaneous location of the tibia and less soft-tissue coverage, leading to morbidity, need for frequent surgical procedures to treat, and permission the patient with functional debits.[3,4]

The U.S. FDA defines a nonunion as a fracture that is at least 9 months old and has not shown any signs of healing for three consecutive months.[5] Tibial nonunion occurs in about 2-10% of all tibial fractures.[6] Fracture repair comprises cell recruitment, osteoinduction, and osteoconduction.[7] Platelets have a chief role in cell recruitment in cooperation in the initial hemostatic phases and the additional phases of wound curing, discharging numerous growth factors and cytokines.[8] Platelet-rich plasma (PRP) is an autologous concentration of human platelets in a small capacity of plasma. This preparation has a very high concentration of growth factors resultant from the granules released upon platelet activation and capable to motivate the migration and growth of bone-forming cells.[8-10] In this study, we compared distal tibia nonunion plating and grafting with and without PRP regarding union rate, union time and complications.

METHODOLOGY

This prospective study of 32 patients with distal tibia nonunion in the young age group was conducted in the Department of Orthopedics, Al-kindy Teaching Hospital, Baghdad, Iraq, from July 2017 to January 2019 with follow up for at least nine months.

Inclusion criteria included both gender, unilateral limb, atrophic nonunion (aseptic), distal tibia fracture, age >20 years <55 years, bone defect <2 cm, and those treated conservatively by casting. Exclusion criteria were skeletally immature and >55 years old, hypertrophic nonunion, bone defect >2 cm, open or pathological fracture, patients treated with previous surgery, and patients unhealthy for an autologous gift (platelet count<$130x10^9$).

Patients were divided into two groups every other patient, all patients treated by open reduction and internal fixation by plating (locking plate) with an autologous bone graft from iliac crest. The first group (group A) with 16 patients (14 males and 2 females) we added PRP, and the second group (group B) with 16 patients (13 males and 3 females) without PRP.

All patients were assessed by full history and proper examination. Written consent after a full explanation was taken from all included patients. X-ray AP and lateral leg views were done for all patients, no CT-scan or bone scan were needed. All patients did preoperative anesthetic workup and preparation and ceftriaxone was given I.V to all patients within one hour before surgery.

During surgical fixation, no tourniquet was used, for group A before skin incision blood was drawn from the patient 50cc from the cephalic or median cubital vein with 50 cc syringe with anticoagulant and then put it in PRP special tube, all done under aseptic technique and all preparation done in the operating theater. We fixed the fracture by 3.5 mm anatomical locking plate medial type. Then we apply the graft to fill the gap at the fracture site and we insert the prepared PRP only for group A by applying most of it at the graft and taking the gel layer to make a puffy coat surrounding the graft. The fibula was left without intervention. No drain was inserted and no back slab was used.

Figure. Post-operative X-Ray A. 3months, B. 6 months C. 9 months.

A B C

Postoperatively, patients started mobilizations from bed day with supports and no weight-bearing for the first 6 weeks. They visited orthopedic clinic at 2 weeks, 6 weeks, 3 months, 6 months, and 9 months postoperatively and each visit infection and wound problems, ankle dorsal flexion and Plain X-ray AP and lateral view were checked (Figure). Pain at the fracture site after starting partial or complete weight-bearing by the m

Statistical Analysis: The data were loaded into IBM-SPSS V24 software for statistical analysis. $p<0.05$ was considered as a discriminated point of significance.

RESULTS

The mean age was 35.43±9.85 years (range 20-52). No statistically significant difference in proportional distribution between genders in both groups in this study (p=0.677) (Table 1). The mean of healing duration in the PRP group was 5.12±0.85 months shorter than group B (6.11±0.45 months) and it was significantly (p=0.001). Visual analog score postoperatively was significantly higher in group B than group A at day 45 visit (p=0.047) and the same thing was noticed at 2nd and 3rd visit with p=0.001, 0.007, respectively, while there was no significant difference in pain at 4th visit (p=0.151).

Table 1. Distribution of studied cases according to gender and the use of PRP.

Gender	N	%	Group A (PRP)	Group B (without PRP)	P-value
Male	27	85%	14(87.5%)	13(81%)	0.677
Female	5	15%	2(12.5%)	3(19%)	

Table 2. Functional outcome regarding pain and callus formation and healing duration.

Functional outcome		Group A (PRP)	Without PRP	P Value
Healing duration	Mean ±SD	5.12 ±0.85	6.11±0.45	0.001
VAS	Day 45	2.6 ± 0.94	3.15 ± 0.74	0.047
	Day 90	1.3 ± 0.57	2.6 ± 0.82	<0.001
	Day 180	0.5 ± 0.13	1.4 ± 0.63	0.007
	Day 70	0.25 ± 0.09	0.65 ± 0.45	0.151
X ray	Day 45	0.65 ± 0.18	0.45 ± 0.11	0.257
	Day 90	2.85 ± 0.88	1.4 ± 0.32	0.052
	Day 180	2.91 ± 0.91	2.3 ± 0.89	0.1
	Day 70	3.4 ± 0.88	3 ± 1.02	0.194

Table 3. Union rate for both groups.

Study arm	Group A (PRP)	Group B (without PRP)	P Value
Complete	13(81%)	11(69%)	0.256
Failure	3(19%)	5(31%)	

Although the means of radiological healing (callus formation) formed in the PRP group at days 45, 90, 180, 270 were showed to be higher than that in the group without PRP, the differences between means were not significant (p=0.257, 0.052, 0.1, 0.194, respectively (Table 2).

The union rate was 81% of patients (13 patients out of 16) with PRP added showed complete union while 69% showed complete union in group B and there was no significant difference (p=0.256) (Table 3).

DISCUSSION

For healing rate and duration, it was found that the use of PRP increased the healing rate and decreased the duration needed for healing significantly. In our study, the healing rate was 81% in PRP group while 69% in the group B, similar to Malhotra et al,[11] Memeo et al,[12] Bielecki et al,[13] Thor et al,[14] Lee et al[15] and Ghaffarpasand et al.[16]

A study by Sanchez et al recommended repeat at least three times injection of PRP to obtain a complete union.[17] Studies against were those of Maricond et al[18] and Say et al who did not obtain satisfactory healing of lower extremity non-union fracture with PRP injection.[19]

Some animal researchers used PRP in management of long bone nonunion defects like Hakimi et al and found that combining PRP and autologous cancellous bone graft resulted in significantly improved bone regeneration related to using cancellous bone graft only.[20]

By comparing of all those results to our study, we found most of them agreed to our study and results that most of the effect appears in the early stages of healing regarding pain or the callus formation. It will be comparable in late stages and this is might be due to the concentration of growth factors in PRP which decreases with time causing in decreased effect on healing.

CONCLUSION

Using the PRP in management of long bone nonunion combined with autologous cancellous bone graft with plate fixation showed a non-significant higher rate of union with a significant decrease in union time. Healing parameters regarding postoperative pain and callus formation showed better results in the PRP group but in the early stage (first 4 months).

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