ORIGINAL ARTICLE

Outcome of Percutaneous Bone Marrow Injection in Femoral Delayed Union and Nonunion

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ABSTRACT

Background: The benefits of autologous bone grafts on bone healing have been recognized for over 100 years. Osteoprogenitor cells aspirated from bone marrow have shown to provide key stimulus for osteogenesis. Regardless of their osteogenic characteristics, the clinical utilization of marrow as an osteogenic source has remained limited.
Aim: To ascertain radiological union with percutaneous autologous bone marrow injection in delayed union and nonunion of femur.
Methodology: This is a descriptive case series study, 35 patients were included in this study and carried out in Orthopaedic Department at Pak Red Crescent Medical College Kasur, 6 months of period from May 2019 to October 2019. Age of patients was 18-60 years of both sexes. Radiographs of affected side were performed to document cases of delayed and nonunion. 50ml of bone marrow aspirated in small fractions from iliac crest was injected at affected site. Results were evaluated at the end of 12 weeks with the help of radiograph.
Results: In this study 33 (94.3%) were males and 2 (5.7%) were females. Mean age was 33.80±10.16 years. Radiological union was achieved in 26 (74.3%) patients.
Conclusion: Percutaneous bone marrow injection is safe procedure without operative morbidity with bone healing in average time of 12 weeks.
Keywords: Radiological Union, Delayed Union, Nonunion.

INTRODUCTION

In spite of continued improvement in operative fixation techniques, treatment of delayed union and nonunion continue to haunt orthopaedic surgeons.

The conventional techniques for autologous cancellous bone grafting to animate skeletal repair has remained unaltered since the work by Phemister[1] detailed over 50 years prior yet operative harvesting of bone and implantation at fracture site has not been without complications[2]. Bone grafting is essentially a second wounding technique, wherein surgeon trusts that the reaction of the body will be more good than the reaction following the original trauma.[3,4] Bone graft materials usually have one or many parts like osteoconductive framework, osteoinductive proteins and osteogenic cells[5,6].

At the point when problem requiring bone substitution, the orthopedic surgeon right now has a few alternatives: autologous or allogenic cancellous or cortical bone, demineralized bone matrix, calcium phosphate-based bone-graft substitute, or autologous bone marrow. Bone-unite substitutes can either supplant autologous bone graft or expand an current amount of autologous bone graft.[6,7] Osteoprogenitor cells suctioned from bone marrow have appeared to give key stimulus to osteogenesis[8,9,10]. In spite of their osteogenic trademark, the clinical utilization of marrow as an osteogenic source has remained restricted. Treatment with bone marrow injection has promising results of 90% radiological union in 12 weeks in femoral delayed as well as nonunion.[1,11,12]

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Pakistan, being a developing country with high percentage of low socioeconomic population where one person is the only bread winner of his family, there is high incidence of trauma resulting in fractures and consequently economical burden on whole family. In association with ignorance and poverty, they frequently take treatment from traditional bone setters. This inadequate treatment very frequently results in delayed union and nonunion. This technique of percutaneous bone marrow injection can be performed as outpatient with obvious better acceptability over bone grafting without donor and recipient site morbidity and resultant decreasing inpatient burden on our hospitals and economical burden on the families[13].

MATERIAL AND METHODS

This is a descriptive case series study, 35 patients were included patients who fulfill the inclusion and exclusion criteria which attending the Orthopaedics Outpatient Department of Pak Red Crescent Medical College, Kasur for the treatment of long bone fractures were the study population. They were clarified about the operation and an informed consent got signed. Risks and advantages of the technique were explained the patients. The demographics profile like age, sex was recorded. Radiographs of affected side were performed in anteroposterior and lateral projections including hip and knee joints.

All patients were kept nil per mouth for 6 hours before operation. All patients got single dose of first era cephalosporin preoperatively. After all aseptic measures, site of delayed or nonunion was localized under image intensifier. 50ml of bone marrow was aspirated from iliac crest using gauge 16 lumbar puncture needle. The marrow was aspirated in small fractions (4ml) to reduce degree of

dilution by peripheral blood and injected at recipient site using technique described by Hernigou[9]. All procedures were performed under supervision. Postoperatively compression bandage was applied for two or three days and encouraged to full weight bear after the procedure. Patients were followed up four weekly in outpatient department and underwent radiological examination. Results of procedure were evaluated at the end of 12 week after procedure. Radiological union was viewed as when plain radiograph indicated bone trabeculae or cortical bone crossing the fracture site.

RESULTS

Out of 35 patients 33(94.3%) were males and 2(5.7%) were females (Table 1). Mean age of patients was 33.80±10.16 years. Out of 35 patients, 4(11.43%) were under the age of 20 years. Eleven patients (31.43%) were in age group of 21-30 years with radiological union achieved in 9 patients at the end of study. Twelve patients (34.28%) were in age group of 31-40 years with radiological union achieved in 10 patients at the end of study. Seven patients (20%) were in 41-50 years with radiological union achieved in 3 patients at the end of study. One patient (2.86%) was in 51-60 years with radiological union achieved at the end of study (Table 2, 3).

Radiological union was achieved in 26(74.3%) patients out of 35 and radiological union was not achieved in 9(25.7%) patients (Table 4). Out of 13 patients of delayed union, radiological union was achieved in 11 (84.61%) patients and was not achieved in 2(15.39%) patients (Table 5). Out of 22 patients of nonunion, radiological union was achieved in 15(68.18%) patients and no union was achieved in 7 (31.82%) patients (Table 6). No single patient developed subcutaneous or deep hematoma, nerve injury, infection or fat embolism after the procedure in early or late period.

Table 1: Sex Distribution of patients (n=35)

Sex	No.	%
Male	33	94.3
Female	2	5.7
M:F ratio	1:16.5	

Table 2: Distribution of Age in Groups (n=35)

Age (years)	No.	%
18-20	4	11.43
21-30	11	31.43
31-40	12	34.28
41-50	7	20.00
51-60	1	2.86
Mean±SD	33.80±10.16	

Table 3: Radiological Union at the End of Study in Different Age Groups (n=35)

Radiological union	Age groups in years					Total
	18-20	21-30	31-40	41-50	51-6-	51-6-
Yes	3	9	10	3	1	26
No	1	2	2	4	0	9
Total	4	11	12	7	1	35

Table 4: Radiological union at 12 weeks after injection (n=35)

Radiological union	No.	%
Yes	26	74.3
No	09	25.7
Total	35	100

Table 5: Radiological union in femoral delayed union (n=13)

Radiological union	No.	%
Yes	11	84.61
No	02	15.39
Total	13	100

Table 6: Radiological Union in Femoral Nonunion (n=22)

Radiological union	No.	%
Yes	15	68.18
No	07	31.82
Total	22	100

Table 7: Comparison number of Cases of Delayed Union and Nonunion

Study	Delayed union	Non union
Present	13	22
Siwach et al[17]	50	22
Hernigou et al[18]	Nil	60
Bhargava et al[8]	25	3
Saikia et al[19]	37	Nil

Table 8: Comparison of Healing Time (in Weeks)

Study	Healing time
Present	12 (9-12)
Siwach RC et al[17]	14 (10-28)
Hernigou et al[18]	12 (4-16)
Bhargava et al[8]	12 (7-18)
Saikia et al[19]	16 (10-26)

Table 9: Comparative Results of Radiological Union

Study	Radiological union at end of study
Present	26/35 (74.3%)
Healy et al[20]	5/8 (62.5%)
Siwach et al[17]	68/72 (94.44%)
Hernigou et al[18]	53/60 (88.33%)
Bhargava et al[8]	23/28 (82.14%)
Saikia et al[19]	28/37(75.67%)

Table 10: Comparison of Complications

Study	Ch pain	Infection	Hematoma	Fat embolism
Present	Nil	Nil	Nil	Nil
Siwach et al[17]	Nil	Nil	Nil	Nil
Hernigou et al[18]	Nil	Nil	Nil	Nil
Bhargava et al[8]	6/28	Nil	Nil	Nil
Saikia et al[19]	Nil	Nil	Nil	Nil

DISCUSSION

Many methods of treating delayed and nonunion of long bones have been developed over past three decades ranging from invasive interventions including corticocancellous bone grafting to non-invasive procedures including bone marrow injection, stimulation by direct current through implanted electrodes, ultrasound therapy and pulsed electromagnetic field about site of fracture[14,15].

Although all these methods have shown varying degree of excellent to good results but most of the techniques are tedious and require sophisticated equipment's, expertise, anesthesia and time consuming with added risk of infection[15]. In current study the impact of percutaneous autologous bone marrow infusion in non-contaminated delayed and nonunion of femur as bone graft substitute was studied. Thirty five cases were considered with majority of cases (22 out of 35) were of nonunion and 13 were of delayed union. Siwach et al[17], reported in his study 50 cases out of 72 were of delayed union (Table 7).

Healing time was 12 weeks (9-12 weeks) after intraosseous injection of autologous bone marrow in the present study. In study by Siwach et al[17], it was 14 weeks (range 10-28 weeks). In study by Hernigou et al[17], it was 12 weeks (range 4-16 weeks). In study by Bhargava et al[8], it was 12 weeks (range 7-18 weeks). In study by Saikiaet al[18], it was 16 weeks (range 10-26 weeks). Healing time is comparable to other studies conducted both locally and internationally (Table 8).

In present study radiological union was achieved in 26 out of 35 patients (74.3%) after bone marrow injection in study duration of 6 months. In study by Siwach et al[17], radiological union was achieved in 68 out of 72 patients (94.44%) in study duration of 7 years. In study by Hernigou et al[19], radiological union was achieved in 53 out of 60 patients (88.30%) in study duration of 10 years (Table 9).

Present study showed that percutaneous autologous bone marrow injection is safe treatment for non-infected delayed and nonunion of long bones as no patient reported back with chronic pain at recipient or donor site, nerve injury, infection or hematoma formation as local complications. There was also no case with fat embolism as systemic complication in present study. In study by Siwach et al[17], Hernigou et al[18] and Saikia et al[19], no local or systemic complication was identified. Only in study by Bhargava et al[8], 6 out of 28 patients reported chronic pain at the recipient site which settled in 2-3 weeks with reassurance and mild analgesia. All studies including the present study proved the safety of the autologous bone marrow injection (Table 10).

CONCLUSION

Percutaneous autologous bone marrow grafting is an effective and safe method for treatment of non-infected delayed and nonunion of long bones. It gives cellular reactivation of osteogenesis without the complications and disadvantages of cancellous bone grafting. This procedure can be performed on an outpatient basis. Moreover, there is nothing to lose even if one fails to achieve union by this simple procedure of percutaneous bone marrow injection. Bone marrow contains osteogenic precursor cells and may become a prime material in future for use in tissue engineering of bone.

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