Role Of Percutaneous Bone Marrow Injection In Delayed Union And Non Union.

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Citation

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Abstract

The present study was conducted in the Department of orthopaedics, Government Medical College, Jammu over a period of one year from June 2005 to May 2006 to evaluate the efficacy of percutaneous bone marrow injection in cases of delayed union and non-union. 50 cases of post-traumatic delayed and non-union (out of 50 cases, 38 were of delayed union and 12 were of non-union), irrespective of their age and sex, were selected from Orthopaedic OPD. Forty-six (92%) out of 50 cases had successful union while four had failures. In case of delayed union, 37 out of 38 (97.37%) patients had successful union and one case did not respond to bone marrow injection. 9 out of 12 (75%) cases of non-union resulted into union where as 3 cases failed to unite. Most of the patients in our series responded to bone marrow injection with union between 12-20 weeks and in cases of delayed union, mean time taken for union to occur was 14.6 weeks and for non-union, mean time taken to unite was 18.4 weeks.

INTRODUCTION

Fracture healing is a specialized type of wound healing response in which the regeneration of bone leads to restoration of skeletal integrity. There are five stages of healing in a fractured bone:

1. Stage of hematoma
2. Stage of subperiosteal and endosteal cellular proliferation
3. Stage of callus formation.
4. Stage of consolidation
5. Stage of remodelling

All these stages are not sharply demarcated and two or more stages may be seen at the same time in different parts of fractured bone. In most of the fractures, healing occurs at a biologically optimum level. However, in sizeable number of cases, it is either delayed or impaired. The time in which a given fracture will unite cannot be arbitrarily stated as different bones heal in variable period of time depending upon many factors but as a general delayed union is deemed to be delayed if the fracture fragments are appreciably mobile even 3-4 months after injury. In delayed union there is clinical and radiographic evidence that healing is taking place but it has not advanced at the average rate for the location and type of fracture.

Non union is said to exist only when actual evidence of cellular activity at the fracture site ceases and fracture is not uniting. According to Boyd and Lipinski, diagnosis of non-union is based on the presence of one or more of the following criteria:

- Painless unnatural mobility (False motion)
- A bony defect
- Sclerosis surrounding the bone ends
- Obliteration of the medullary canal.

FDA panel has defined non-union as established when a minimum of 9 months have elapsed since injury and the fracture shows no visible progressive signs of healing for the last 3 months.

Autologous bone grafting has been the standard operative method for decades since the work of Chutro and later Phemister and others which involves the operative removal of bone from a donor site, usually pelvis and operative implantation at the site of delayed or non-union. Autologus bone potentially contributes three vital components for

healing which are osteoconduction, osteoinduction and osteogenic cells. But operative harvesting and implantation at the fracture site has not been without complications both at the donor and recipient sites. Painful scar, hematoma, infection, fracture or subluxation and gait disturbances have been reported among the problems at the donor site. The non-operative methods include the use of low intensity ultrasound, electrical stimulation and electromagnetic stimulation. But these procedures are tedious, require sophisticated equipments, expertise and anaesthesia and are time consuming. Hence a continuous search has been made to find out such an alternative method of treating delayed and non-union which is safe, easy and economical. In recent times, percutaneous bone¬ marrow injection has emerged as a successful alternative to traditional methods of treatment. It is a minimum invasive procedure with negligible complications. It is performed in an outpatient setting under local anaesthesia mostly. So it decreases cost and hospital stay. The ability of marrow to form bone has been known for more than a century since the experimental work of Goujon in1869, who observed the formation of the bone at a heterotropic site after red marrow was transplanted as an autograft. A number of subsequent studies on animals showed that autologous bone marrow contains osteogenic precursor cells. Encouraged by the success, simplicity and minimal complication of bone marrow grafting for delayed and non union in experimental studies and clinical trials, the present study has been taken up to evaluate the efficacy of this procedure over a period of one year in our institute.

AIMS AND OBJECTIVES

To evaluate the efficacy of percutaneous bone marrow injection in cases of delayed union and non union.

MATERIALS AND METHODS

The present study was conducted in the Department of orthopaedics, Government Medical College, Jammu over a period of one year from June 2005 to May 2006 to evaluate the efficacy of percutaneous bone marrow injection in cases of delayed union and non-union. 50 cases of post-traumatic delayed and non-union (out of 50 cases, 38 were of delayed union and 12 were of non-union), irrespective of their age and sex, were selected from Orthopaedic OPD after which they were examined clinically and radiologically to establish the diagnosis on the basis of following criteria:¬

INCLUSION CRITERIA

CLINICAL

1. Age of fracture more than 12 weeks.
2. Abnormal mobility at the fracture site.
3. Tederness at the fracture site.
4. Pain on applying bending stresses.

Radioloigical:

1. Gap at the fracture site.
2. Insufficient amount of callus.
3. Sclerosis of fracture ends.
4. Obliteration of bone marrow cavity at the fracture site.

EXCLUSION CRITERIA

Patients with infection and local malignancy were excluded from the study.

OPERATIVE TECHNIQUE

This procedure was performed as an outdoor / indoor procedure under local anesthesia/ short general anesthesia. Under all aseptic precautions, patient was put in supine position and donor and recepient sites were prepared separately but simultaneously to prevent cross - contamination of needles. Bone marrow was aspirated from the donor iliac crest with a bone marrow aspiration needle connected to a 20 ml syringe. About 10 ml to15ml of marrow was aspirated from one site and to obtain more, multiple aspirates were done. The aspirated marrow was injected percutaneously immediately at the recepient fracture site with the help of a 16 gauge spinal needle under C¬- arm. On random basis, aspirate slides were made to confirm bone - marrow cells under microscope. After bone marrow injection, the recepient site was immobilized either by Plaster of Paris cast or with the help of braces Donor site was dressed and sealed. Serial X-Rays were taken at interval of 4-6 weeks (including special views to see callus formation) and if needed, second injection was repeated.

Assessment of results: ¬

All cases were followed after an interval of 4-6 weeks for 6 months following the bone marrow injection. The clinical as well as radiological assessment of union was done as per details in the proforma attached.

CRITERIA FOR UNION

CLINICAL

1. No abnormal mobility at the fracture site.
2. No pain at the fracture sites on applying bending stresses.
3. No tenderness.

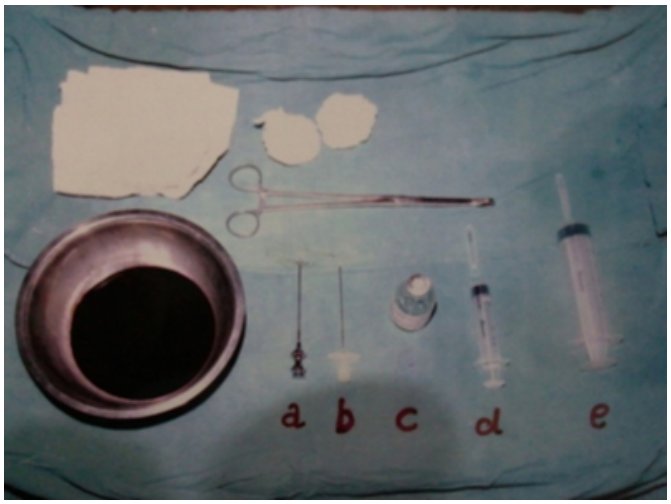
RADIOLOGICAL

1. No gap at the fracture site
2. Sufficient amount of callus.

INSTRUMENTATION

Figure 1

Fig. 1 Showing instruments used in the procedure of percutaneous bone marrow injection.



1. SILVERMAN BIOPSY NEEDLE
2. SPINAL NEEDLE 16 GUAGE
3. XYLOCAINE 2%
4. 10 ml SYRINGE
5. e20 ml SYRINGE

Figure 2

Fig 2: showing aspiration of bone marrow from iliac crest with the help of bone marrow aspiration needle attached to 20 ml syringe.

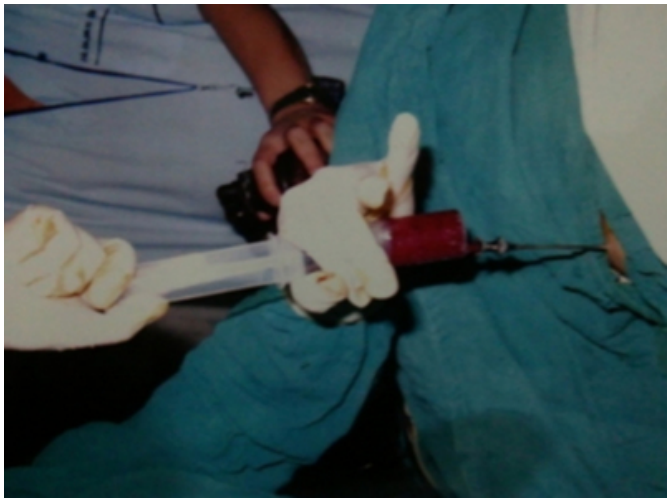
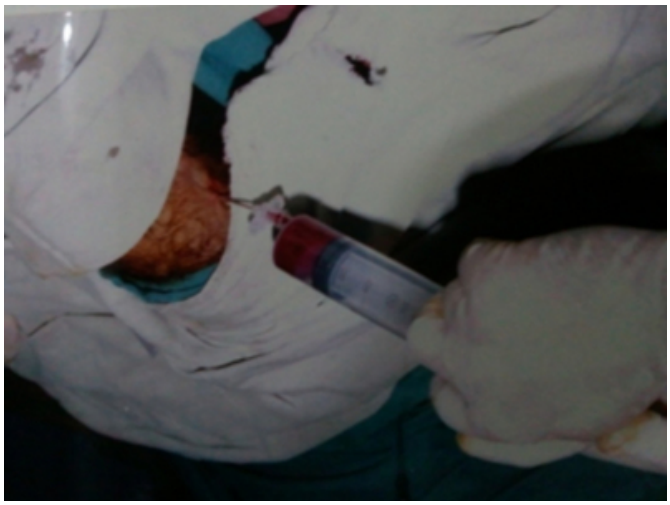


Figure 3

Fig 3: Showing injection of aspirated bone marrow at the recipient fracture site with the help of 16 gauge spinal needle.



OBSERVATIONS

The present study was conducted in the Department of orthopaedics, Government Medical College, Jammu over a period of one year from June 2005 to May 2006 to evaluate the efficacy of percutaneous bone marrow injection in cases of delayed union and non-union. 50 cases of post-traumatic delayed and non-union (out of 50 cases, 38 were of delayed union and 12 were of non-union), irrespective of their age and sex, were selected from Orthopaedic OPD and bone marrow grafting done. After six months of follow up of each case, results of study were compiled and following observations were recorded.

The mean age of patients was 36.2 years. The maximum number of patients i.e. 33 (66%) were found in age group of 21-40 years. 1 case (2%) was above 60 years while 2 (4%) patients were below 21 years. The minimum age was 20years and maximum was 65 years. Of all patients, 39(78%) were males and 11(22%) were females. In the present series, majority of the cases had delayed / non-union of tibia. 27 out of 50 cases i.e. (54%) were of tibia, 14(28%) cases were of femur, 3 (6%) were of humerus, 2 each of ulna & scaphoid and 1 each of radius and both radius & ulna. Out of 50 cases 5(10%) had delayed union of 12-16 weeks, 11(22%) had delayed union of 20-24 weeks, 9(18%) had delayed union of 24-28 weeks . 2 cases (4%) had non union of 32-36 weeks, 5 cases(10%) had non union of 36-40 weeks, 3 cases(6%) had non union of 40-44 weeks, 1(2%) of 44-48 weeks & 48-52 weeks each and 2 cases had non union of >52 weeks duration. Minimum duration of injury prior to bone marrow injection was 14 weeks and maximum was 104 weeks. Mean duration of injury prior to bone marrow injection was 28.1 weeks. Out of total of 50 cases in this series, 38 cases (76%) were of delayed union and 12 cases (24%) were of non-union. In our study, internal fixation had been carried out in 17 cases, whereas external fixation had been applied in 3 cases prior to bone marrow injections and rest of 30 patients had been treated conservatively before injecting bone marrow. Local anaesthesia was used in 39 cases and short general anaesthesia in 11 cases. In our study to test the efficiency of autologous bone marrow injection given percutaneously, one injection was given in 30 cases (60%) and in 20 cases (40%) injection was repeated. In the present series of 50 cases of delayed and non-union treated, 46(92%) had successful union while we had failure in 4(8%) cases. Out of 38 cases of delayed union, success was achieved in 37(97.37%) cases, while we had failure in 1(2.63%) case. Out of 12 cases of non-union included in this study, union was achieved in 9 cases (75%) while we had failure in 3 cases (25%). Mean time for appearance of callus in successful cases is 4.9 weeks (Table 1). It was observed that most of the cases united with in 12-22 weeks after bone marrow injection. In our study, mean time taken for union was 15.3 weeks. Mean time taken in cases of delayed union to unite after bone marrow injection was 14.6 weeks where as for non-union was 18.4 weeks.

Figure 4

Table 1: Time for appearance of callus in successful cases.

Periods in weeks	No. of Cases	Percentage
4-6	36	78.26
6-8	8	17.40
8-10	2	4.34
10-12	0	0
Total	46	100

Figure 5

Table 2: Time taken for union in successful cases

Period in weeks	No of successful cases	
	Delayed union	Non-union
8-10	4	0
10-12	4	0
12-14	9	0
14-16	2	2
16-18	10	1
18-20	5	2
20-22	3	3
22-24	0	1
Total	37	9

Figure 6

Fig 4: X- ray femur showing delayed union (6 month old).

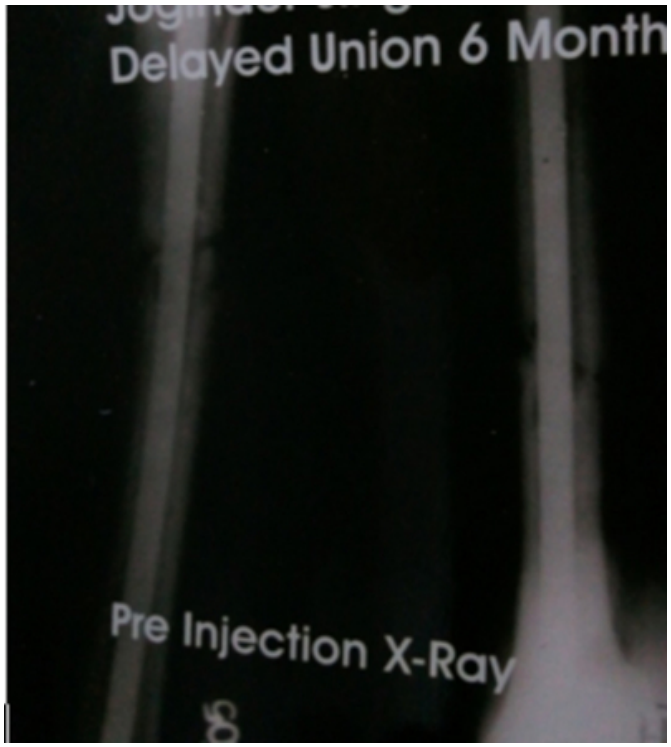
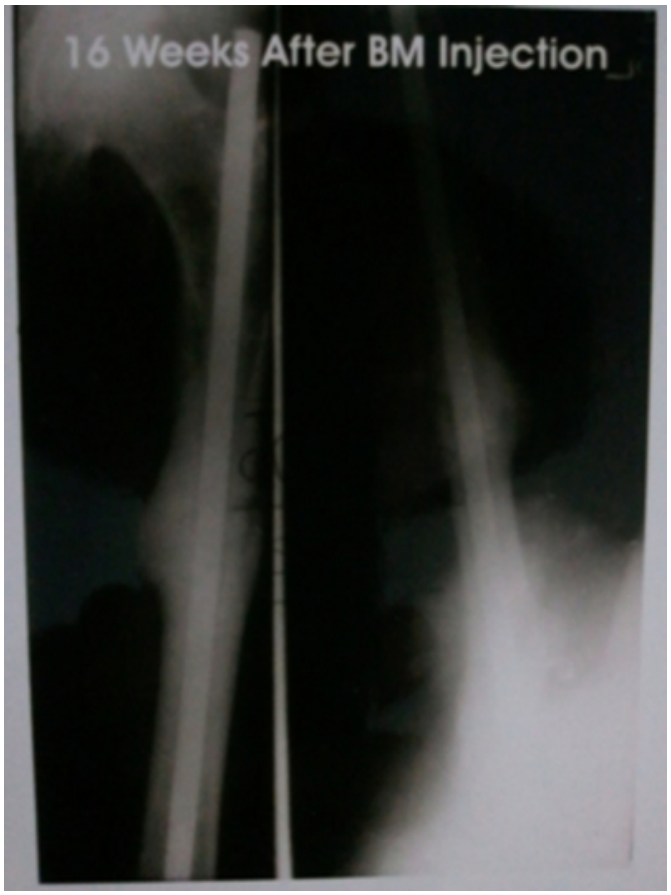


Figure 7

Fig 5: 6 weeks after bone marrow injection.

Figure 8

Fig 6: 16 weeks after bone marrow injection showing union.



COMPLICATIONS

In our series of 50 cases of delayed union and non union grafted with autologous bone marrow by percutaneous injection, except for little pain during aspiration of bone marrow (that too under local anesthesia), no complication like vasovagal shock etc. was seen. There was no complication at recipient site too. No cases were reported with compartment syndrome or skin necrosis at recipient site. No sign of infection at donor or recipient site was encountered in any patient included in this study. It was observed that at times, the injection of bone marrow at fracture site became difficult whenever there was slight delay in injecting the aspirated marrow at the fracture site. This technical difficulty was avoided by inserting the 16-guage spinal needle at the fracture site under C-Arm prior to aspiration of bone marrow from iliac crest so that the procedure could be completed as readily as possible.

CONCLUSION

In the present series, 38 (76%) out of 50 patients were of delayed union while 12 (24%) were of non-union. Forty-six (92%) out of 50 cases had successful union while four had failures. ln case of delayed union, 37 out of 38 (97.37%) patients had successful union and one case did not respond to bone marrow injection. 9 out of 12 (75%) cases of non-union resulted into union where as 3 cases failed to unite as all these three cases had soft tissue interposition between fracture fragments that become apparent at the time of open bone grafting which was done subsequently in these cases. In 95% of cases, callus started appearing within 4-8 weeks of bone marrow injection with mean time of appearance of callus being 4. 9 weeks. Most of the patients in our series responded to bone marrow injection with union between 12-20 weeks and in cases of delayed union, mean time taken for union to occur was 14.6 weeks and for non-union, mean time taken to unite was 18.4 weeks. To conclude with, our study has established that bone marrow has high osteogenic potential and can be grafted percutaneously quite successfully. This procedure of bone marrow giafting by percutaneous injections has tremendous clinical potential with no complications. This minimally invasive procedure is biological method of bone grafting as it does not disturb the vascularilty at the fracture site. It is an easy, safe, simple, economical and short procedure that can be performed as an outdoor procedure under local anaesthesia. So, it is a very useful procedure for those patients who are not fit for general anaesthesia. It is both patient as well as surgeon friendly procedure. In short, it is an easy substiution of a complex problem.

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