



E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2021; 7(1): 229-231
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www.orthopaper.com
Received: 15-11-2020
Accepted: 18-12-2020

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Clinical and functional outcome of percutaneous bone marrow injection in delayed union and non-union of long bone fractures

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DOI: <https://doi.org/10.22271/ortho.2021.v7.i1d.2486>

Abstract

Non-union and Delayed union is still major challenge to the orthopaedic surgeon. Bone grafting are the basic principle in the treatment of non-union and delayed union. However complications is always concern. To minimize this risk, percutaneous bone marrow injection has been suggested as an alternative, this provides a source of oestrogenic cells with osteoinductive effect.

Aim: To study percutaneous bone marrow injection in delayed union and non-union of long bone fractures.

Materials and methods: The study Sample will be taken from the patients treated in P.D.U. Medical College and Hospital diagnosed as a delayed and non-union on basis of x rays. Under general or spinal anaesthesia, bone marrow was aspirated from the anterior superior iliac crest OR posterior superior iliac spine using bone marrow aspiration needle. The aspirate was injected percutaneously into and around the fracture site under fluoroscopy control.

Results: In our study of 30 cases of Delayed union and non-union, 19 (63.33%) cases achieved Union while 11(36.67%) cases Union not achieved by using percutaneous bone marrow injection.

Conclusion: Bone marrow injection technique is simple technique which has high oestrogenic potential. This minimally invasive procedure is safe, easy, simple, economical and short procedure.

Keywords: Bone marrow injection, delayed union, non-union

Introduction

Non-union and Delayed union are still major challenge to orthopedic surgeons. Numerous method have been adopted to overcome this problem such as bone graft, electrical stimulation, ultrasound, bone marrow injection. Stabilization and open bone grafting are the basic principle in the treatment of fracture non-union and delayed union. Autologous bone graft is most efficient method used to treat fracture nonunion and delayed union. Autologous bone for bone graft is harvested from iliac crest; this could result in significant pain and morbidity. In our study grafting with autologous bone marrow can obtain healing of non-union and delayed union. Bone marrow from iliac crest have long been the most prevalent and effective method of cell transplantation. We treated 30 patients with delayed and non-union by simple closed bone marrow injection into fracture site. The concept of percutaneous bone marrow injection was introduced by Herzog in 1951. McGaw and Habin were among the first to demonstrate the estrogenic activity of bone marrow. Bone marrow contains osteoprogenitor cells capable of differentiating into osteoblast, chondrocytes, adipocytes and muscle cells. The osteogenic capabilities of bone marrow prompted surgeons to begin using it as a bone graft material. Relationship between bony union and bone marrow is as follow: some of cells of callus originate in bone marrow and bone marrow cells are responsible for the formation of part of the bony callus. Bone marrow stem cells developed into hematopoietic and non hematopoietic stem cells or marrow stromal cells, which are progenitors of skeletal tissue components such as bone and cartilage as well as blood components. In this study, we investigated the efficiency of autogenous bone marrow injection in the treatment of non and delayed union of long bone fractures.

Patients and Method

Study was carried out at Orthopaedics department of P.D.U. civil hospital, Rajlot. A total 30 patients with delayed union and non-union of long bones were treated with percutaneous

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bonemarrow injections.

Delayed union was diagnosed when there is no sign of progressive union in x ray by 3 months post injury. Non-union was diagnosed clinically by when 9 months has elapsed since fracture with no visible progressive signs of healing for 3 months. Inclusion criteria includes Age >18 years, Non-union and Delayed union of long bone fractures, all fractures had acceptable alignment and stable fixation with minimal deformity and minimal angulation. Exclusion criteria includes delayed union or non-union due to active infection, Pathologic fracture, mechanical cause related to internal fixation requires revision of the fixation, Compound fractures with nerve injury, arterial injury. Method: Anesthesia = spinal anesthesia or short general anesthesia, After painting and drapping a 1 cm small incision was made at the level of anterior iliac crest and a bone marrow needle (Jamshidi needle) was introduced into the cancellous part of the iliac crest in between inner and outer table, down at the depth of 2 to 3 cm. Bone marrow was aspirated in small volumes (3 to 5ml) to avoid dilution by peripheral blood, using 20 ml plastic syringe. After one full turn, the trocar was slightly withdrawn towards surface and the same process repeated until desired volume obtained. Then under fluoroscopic control (c-arm) the bone marrow was injected percutaneously into and around fracture site by using 18 or 20 gauge needle or by using spinal needle. After injecting bone marrow compression was given for five minutes.

Results and Discussion

In this study which included 30 patients, we observed union in 19 patients (63,33%) which is comparable to other similar studies. Most of the cases in our study were diagnosed as delayed union. Bone marrow was injected in most of the cases at a minimum of 3 months following the initial treatment. Fractures which failed to show expected progression towards healing were selected for the study. Only cases with minimal gap and displacement were selected for the study. Although there was high selection bias in favor of union, it cannot be said that union in these cases would have occurred even without the procedure. After bone marrow injection the fracture united rapidly, Hence it is clear that the percutaneous bone marrow injection had helped the fracture to unite, it had definitely accelerated healing process. Out of 20 cases of delayed union, 15(75%) cases Union achieved and Out of 10 cases of non-union, in 4(40%) cases Union achieved (Table 1). Among the 20 Closed fracture, 11(55%) achieved Union and out of 10 cases of compound fracture, in 8(80%) cases Union achieved (table 3). Fracture treated by closed methods initially at the time of injury showed better Union, 15 out of 24 cases(62.5%), where as those treated by open Procedure (plate) showed Union in 3 out of 6 cases (50%). Bone marrow injection was found more useful in cases of delayed union as compared to non-union cases. There were no donor site infection or recipient site infection noticed in this study. We recognize the limitations of our study, the number of patients is small and there is no control group. Furthermore, apart from plain radiographs we did not use sophisticated investigations for diagnosing non-union or establishing union. We used clinical and radiological criteria in addition to patient's confidence to pain free weight bearing as a parameter to solid union. We would like to highlight percutaneous bone marrow grafting as a limited invasive technique which is a simple, safe, inexpensive and effective method of treating Delayed union and non-union. This makes it worth exploring before embarking on more extensive open surgery. Complication associated with bone graft are infection, persistent pain, abdominal hernia, hematoma formation, cosmetic deformity, pelvic Instability ileus, nerve injury. By using bone marrow injection these complications

can be avoided as bone marrow injection procedure is minimal invasive, safe, easy, simple, economical and short procedure. Further study is required to evaluate results of bone marrow injection for delayed union and non-union with larger sample size. Platelet rich plasma (PRP) obtained from bone marrow concentrate is also useful for fracture union. We highly recommend this technique for those patients with delayed union and non-union.

Table 1: Relationship between state of union and healing

State of union	Union achieved	Union not achieved	Total
Delayed union case	15 (75%)	5 (25%)	20 (100%)
Non-union case	4 (40%)	6 (60%)	10 (100%)
Total	19 (63.33%)	11 (36.67%)	30 (100%)

Table 2: Relationship between site of fracture and healing

Site	Union achieved	Union not achieved	Total
Humerus	9	3	12
Femur	4	4	8
Tibia	5	2	7
Radius	1	2	3
Total	19	11	30

Table 3: Relationship between type of fracture and healing

Type	Union achieved	Union not achieved	Total
Closed	11 (55%)	9 (45%)	20 (100%)
Compound	8 (80%)	2 (20%)	10 (100%)
Total	19 (63.33%)	11 (36.67%)	30 (100%)

Table 4: Relationship between initial treatment and healing

Initial treatment	Union achieved	Union not achieved	Total
Cast	1	1	2
Nail	12	6	18
Ex-Fix	3	1	4
Plate	3	3	6
Total	19	11	30

Table 5: Relationship between number of bone marrow injection and healing

No. of BMI	Union achieved	Union not achieved	Total
1	11	1	12
2	7	7	14
3	1	3	4
Total	19	11	30

Table 6: Time taken for radiological union

Radiological union	Union achieved
3rd month	12
6th month	6
9th month	1
Total	19



Fig 1: 9 months following fixation



Fig 2: 1 month following 1st BMI



Fig 3: 1 months following 2nd BMI



Fig 4: Final follow up (Fracture united)

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Conclusion

The use of bone marrow injection to accelerate fracture healing is one of the application of stem cell technology. It represents a promising method of application of tissue engineering in the orthopaedic field. Bone marrow injection treatment is relatively less invasive and cheaper than gold standard procedure bone grafting with same osteoinduction properties with less morbidity and complication. Hence it can be used in non-union and delayed union of long bone fractures.

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