



ORIGINAL RESEARCH PAPER

Orthopaedics

THE EFFECTS OF BONE MARROW INFILTRATION IN DELAYED UNION AND NON UNION OF LONG BONE FRACTURES IN TERTIARY CARE HOSPITAL

KEY WORDS: Bone marrow, delayed union, nonunion

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ABSTRACT

Bone marrow is a good source of osteoprogenitor cells. Being a simple and minimally invasive technique with lesser complications, this study is intended to evaluate the effectiveness of bone marrow injection in delayed union and nonunion and thus decrease the period of morbidity for the patients those are likely to go for nonunion. Learning curve is short. It can be considered as an alternate method for bone grafting in delayed union and nonunion of fractures of long bones.

INTRODUCTION

Bone is a tissue in which the ability to regenerate is more predictable than in any other tissue of the body. Fracture healing is a specialized type of wound healing in which the regeneration of the bone leads to restoration of the skeletal integrity. The stages of healing are hematoma formation, cellular proliferation, Callus formation, Consolidation and remodeling. In most of the fractures healing occurs at a biologically optimum level. However in a small proportion of cases it is delayed or impaired. Union is considered Delayed when the healing has not advanced at the average rate for the location and type of fracture (usually 3 to 6 months). The U.S Food and Drug Administration panel defined nonunion as “established when a minimum of 9 months has elapsed since injury and fracture shows no visible progressive signs of healing for consecutive 3 months. 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. In delayed union there is clinical and radiological 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. The diagnosis of the non union is based on the presence of one or more of the following criteria like painless abnormal mobility, bony defect , sclerosis surrounding the bone ends and obliteration of the medullary canal. Bone marrow is a good source of osteoprogenitor cells. The ability of marrow to form bone has been known for more than a century since the experimental work of Goujon in 1869. Burwell used the osteogenic potential of autologous red marrow to create osteogenesis in allogenic cancellous grafts. Bone marrow has also been used in combination with osteoinductive materials such as bone morphogenic protein (BMP), demineralised bone matrix and as a composite graft with bioceramics.

The concept of percutaneous bone marrow injection was introduced by Herzog in 1951. McGaw and Habin were among the first to demonstrate the osteogenic activity of bone marrow. Being a simple and minimally invasive technique with lesser complications, this study is intended to evaluate the effectiveness of bone marrow injection in delayed union and non union and thus decrease the period of morbidity for the patients those are likely to go for non union.

R.Sim et al reported a retrospective study of autologous bone marrow injection for treatment of delayed union and nonunion fractures conducted by Orthopaedic department, Singapore general hospital from 1990-1991 which included 10 patients with 11 fractures(8 tibia and one humerus, femur and radius/ulna). Marrow injection stimulated a callus formation sufficient to unite 9 of the fractures. Median time to

clinical union was 10 weeks (4-23 weeks) and radiological union 17 weeks (9-29 weeks). Bone marrow injection was effective in stimulating bony union, with numerous advantages and considerably low morbidity compared with open autologous grafting. Shorter inpatient stay was a significant feature.

R.Bhargava et al conducted another study in 2007 which included 28 patients with non-union or delayed union who were treated with bone marrow injection. Of these 28 patients two patients had fracture shaft femur, one had fracture shaft ulna and 25 patients had tibial shaft fractures. The average time duration between procedure and injury was 25 weeks (14-53 weeks). Bone marrow was aspirated from the iliac crest and injected into the fracture site. Procedure was carried out as an outpatient procedure. Union was observed in 23 cases. The average time of healing after procedure was 12 weeks (7-18 weeks). This technique was found to be very safe, easy and reliable alternative to open bone grafting.

MATERIALS AND METHODS

34 patients with non union or delayed union were treated with percutaneous bone marrow injection. 26 out of 34 patients were males. Cases were considered as delayed union if there was no sufficient callus formed in the first 3 months of follow up. In cases of delayed union bone marrow injections were given at a minimum of 3 months after the initial treatment with closed or open technique. Cases were considered as nonunion or anticipated to result in nonunion if there was no improvement in progression towards healing for consecutive 3 months. The average age of the patients were 41.8 years (18-79 years). This study included 11 femur, 13 tibia , 6 humerus, 4 radius . The time period from fracture treatment to bone marrow injection varied from 2 to 24 months. Study included 23 closed fractures, 9 cases of Gustilo Anderson Type 1 open fracture , and one each of type 2 and type 3. There were 28 cases of delayed union and 5 cases of non- union. Open procedures were done in 15 and closed in 17 fractures

OPERATIVE PROCEDURE

All procedures were done in operation theatre after obtaining written informed consent. Patient was placed in supine position under Spinal anaesthesia. Iliac crest was painted and draped along with the site of delayed or non union. About 25-40ml of bone marrow aspirated from this site and injected into the recipient site using aspiration needle under radiological control. Post operatively dressing was applied and patients were discharged in 2-4 days. Patients were followed up clinically and radiologically at an interval of 6 weeks till an average of 8 months (3- 15 months). Clinically patients were checked for tenderness, abnormal mobility, pain on weight bearing. Radiologically patients were evaluated for callus

formation. Patients were also evaluated based on musculoskeletal society scoring system as well as hammers table.

CASE STUDY

In this study 24 out of 33 patients showed good union (72.7%) which is consistent with the other similar studies. Out of 28 delayed union cases 22 showed good union (78.6%) compared to union in 5 (40%) of the non union cases. The fractures which were treated by closed reduction methods initially showed better union. Patients below 45 years showed good union compared to older age groups. The effect of bone marrow on non union cases and comminuted cases cannot be commented upon as the sample size is less. P value was found significant (<0.5) for the age, status of union at the time of bone marrow injection and quantity of bone marrow injected

DISCUSSION

Various methods of treatment were sorted for delayed and non union from decades which includes exchange nailing, bone grafting, stimulation by electric current and electromagnetic field, ILLIZAROV fixation. However the standard procedure of bone grafting was found to have associated complications as mentioned.

The osteogenic and osteoinductive property of bone marrow were first described by McGraw and Habin, Connolly and Healy have demonstrated that percutaneous bone marrow injection can successfully treat 78%-95% of non union cases. The work of Paley et al showed experimentally that marrow produces optimal effect when used early in fracture healing process.

Other similar recent studies has showed good union in their series of patients and concluded that percutaneous bone marrow injection is safe and easy procedure. The only complications noticed were infection and pain at the donor site which were subsided by analgesics and antibiotics.

In this study which included 33 patients, we observed union in 24 patients (72.7%) which is comparable to other similar studies. Most of the cases in our study were diagnosed to have 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 as the mean time duration between the procedure and injury was about 22 weeks (5.4 months).

After bone marrow injection the fractures united in mean of 17 weeks. Hence it is clear that the percutaneous bone marrow injection had helped the fracture to unite, it had definitely accelerated the healing process.

The fractures treated previously by closed technique had union in 78.6% and those treated with open procedure the union was seen in 67%. Out of the 5 non-union cases, 2 cases showed union, 1 case showed progressive healing and 2 resulted in nonunion. Out of the 28 delayed union cases 22 united (78.6%). The average hospital stay was 4 days ranging from 2-5 days.

Bone marrow injection was found to be more useful in cases of delayed union as compared to nonunion cases.

The effect of bone marrow injection in cases with nonunion of fractures cannot be commented upon as the sample size was less.

The age of the patient, state of union, type of fracture, quantity

of bone marrow injected played a significant role with p value < 0.5.

There was no donor site or recipient site infection noticed in this study.

CONCLUSIONS

Bone marrow infiltration is a minimally invasive procedure done percutaneously. It is easy, safe procedure with no associated complications that may occur in bone grafting, thus reducing hospital stay and expenditure. Learning curve is short. It can be considered as an alternate method for bone grafting in delayed union and non union of fractures.

It can be given in cases in which delayed union is diagnosed or anticipated so as to prevent those fractures resulting in non-union and thus reducing the morbidity associated with non-union.

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