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Result of Autologous Bone Marrow Injection Delayed Union and Non - Union of Long Bone Fractures

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Abstract

Delayed union and non union of bone fracture is becoming less frequent ,but still remains a challenging clinical problem. Autologous calluses bone graft that is gold standard method often involves donor site morbidities and complications ,so we treat patient by less invasive procedure which is bone marrow injection in fracture site. In the process of bone formation and healing of fractures, the bone marrow as a source of osteo progenitor cells which are the most important factor in this process .The aim of this study is to show the effect of bone marrow injection in management of delayed union and non-union. fifty four patients(30 patients femur and 24 patients tibia) with delayed union and non union were treated by bone marrow injection .Most of cases have fractures of the long bones. The bone marrow were aspirated from the anterior iliac crests and then injected percutaneously into the fracture site. Full union was achieved in 50 cases, while failed in the others (4 cases). The mean time for union was 4-12 months weeks ;no major complications were seen during or after the procedure. The usage of bone marrow injection in the treatment of delayed union and non-union is a safe, easy and a minimally invasive procedure under fluoroscopy and general anesthesia or spinal epidural compared to usual open bone graft especially for cases with high risk of anesthesia or risk of infection .at injection site after or donor not costly and no need for log hospitalization .

Keywords: Delayed union. Non-union. Osteogenic precursor cells and bone marrow injection .

Introduction

Us FDA state non union as when minimum 9 months has elapsed since injury and fracture shows no progressive signs of healing for 3 months **(1)**. One of the major complications in fracture treatment were delayed union and non-unions , because any fracture will end either by union or nonunion. Delayed union, by definition, is present when an adequate period of time has elapsed since the initial injury without achieving bone union. The fact that a bone is delayed in its union does not mean that it will become a nonunion. Nonunion is one end result of a delayed union, and the differentiation between the two is sometimes difficult to make. Classically the stated reasons for delayed union and nonunion are problems such as inadequate reduction, inadequate immobilization, distraction, loss of blood supply, and infection .There are various factors that is used to enhance union , such as drugs, electromagnetic fields, distraction and compression osteogenesis by illazrov, autogenous bone graft, a more specifically bone morphogenic protein injected in fracture site.The concept of percutaneous bone graft was introduced by Herzog in 1951.heused along bone needle and small can cellous chips to graft anon- union**(2)** .McGaw and Habin were among the first to demonstrate the

osteogenic activity of the bone marrow**(3)**. The osteogenic precursor cells which are capable of producing bone have been demonstrated among the stromal and endosteal cells of the bone marrow which are the key element in the process of bone formation and fracture healing **(4,5).**The demonstrated marrow cells supplement perosteal and primitive mesenchymal cells to form cellular component of bone healing. The capacity to heal a fracture.

Patient and Methods

This is a clinical trial study done in Baqubah teaching hospital in the period from Jan. 2010 to Jan.2016. 54 patients with delayed and non-union of long bones were selected for bone marrow injection. We select patients with delayed union and nonunion depending on the criteria that delayed union is lack of callus formation for more than 6 months, while non- union is lack of union after 9 months or no progression of healing for 3 months**(6).** The patients age ranged from (20-50) yrs. most of the cases suffered closed 44 and compounds10 cases fracture of one of the long bones.30 cases of fracture femur (26 internal and 4 external fixation) ,24 cases of fracture tibia(18 internal and 6 external fixation). Open bone grafting technique were risky in those cases (most of the cases having multiple shells or previous history of bone infection).The bone marrow were aspirated from the anterior iliac crest and injected into the fracture site under fluoroscopic control. The procedure were done in the operative theatre ,under general anesthesia or spinal or epidural and fluoroscopic technique . The marrow aspirated via special bone marrow aspiration needle, the aspirate was injected into the fracture site using a bone marrow needle. The procedure done under complete aseptic technique .The same external fixation or plaster cast immobilization was continued after the injection .antibiotics given post injection three shut .Weight bearing was not allowed in the first few days to reduce pain and oedema at injection site .the patient were followed for a mean period of 6 months by serial radiographs every 6 weeks until the appearance of callus and union. If there is no callus after the first injection the procedure were repeated within 6 weeks. We repeated the procedure for maximum, of 3 times. The patient followed until either a full union.

Results

The study revealed that clinical and radiological union(depending on x-ray follow up)was achieved successfully in 50cases (92%), while the other 4 cases (8%) failed to unite. Most of the cases needed repeated injections to achieve union.The mean time of callus to appear radiologically was 7.5 weeks, in 50 cases (92%) callus did appear after bone marrow injection yet one case failed to unite fully .The mean time for union was 32weeks. No major complication was seen during and after the procedure, only a few cases developed pain at the donor site that subsides within few weeks. 1 cases developed infection, one of them controlled by antibiotics while the other ended with failure. The table(1) shows that the age group from 20-29 and from 30-39 is the most common one to be affected by fractures. The table (2) shows that the younger the age group the earlier the callus well appear. Table (3) relation of callus appearance and fracture type. The callus appears earlier in closed fractures as shown by the table. Table (4) fracture site and number of patients. The tibia is most common bone to have delayed or non union..Table (5) complications of procedure. Poor patient compliance was the most common complication. We noticed that the earlier bone marrow injection was given from the time of fracture the earlier callus formation and the best results were observed.

Table (1) shows patients according of age.

Age in years	Patient number	Percentage%
20-29	20	37
30-39	20	37
40-49	10	18.5
>50	4	7.4

P>0.05

Table (2) shows that the younger the age group the earlier the callus well appear.

Age in years	Callus 4 wks	Appearance 8wks	In weeks 12wks	Non
20-29	8	6	6	-
30-39	7	6	7	-
40-49	-	6	2	2
>50	-	2	-	2

P<0.05

Table (3) relation of callus appearance and fracture type. The callus appears earlier in closed fractures as shown by the table

Type of fracture	Callus 4wks	Appearance 8 wks	In weeks 12wks	Non
closed	44	30	14	-
opend	10	6	-	4

P<0.05

Table (4) show the fracture site and number of patients.

Fracture site	Number of patients	Percentage %
Tibia	24	44.4
Femur	30	55.5

P<0.05

Table (5) complications of procedure

Complications	Number of cases
Infection	1
Pain	1

P>0.05

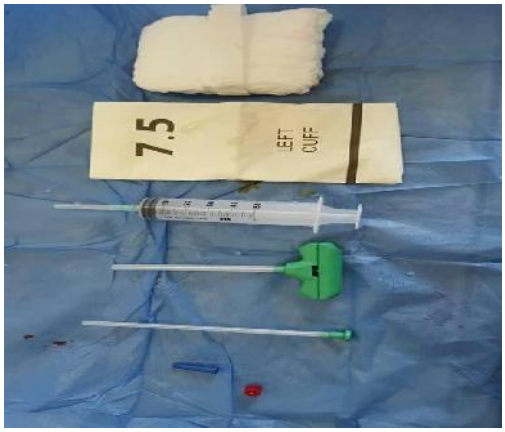

Figure 1: set used for injection

Figure 2: Aspiration for anterior iliac (aspiration of bone marrow for join site interior iliac crest)

Figure 3: Femur fracture delay union before and after

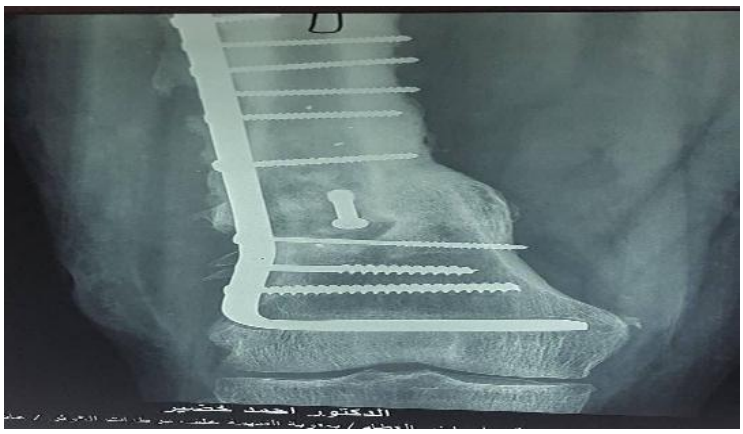

Figure4: Fracture tibia after injection at the lower site

Discussion

Delayed union and nonunion have been treated by various methods such asonlay bone graft, dual on lay bone graft, cancellous insert graft with or without fixation, stimulation by various methods (electromagnetic fields and others). Despite the advances in bone grafting materials and technique open autologous bone grafting still remains the standard treatment of nonunion. Phemister in 1930 showed that the morbidity associated with these procedures is significant and the increase risks of additional open surgery can be prohibited in certain cases (7, 8, 9). In recent clinical studies percutaneous injections of BMA have achieved successful healing in 75 to 95% of non union. The differences among these healing rates may be attributed to variations in techniques and patients population to which they are applied (10,11,12).Poor soft tissue coverage and the presence of foreign bodies (shells) was the reason to avoid extensive open surgical procedures in most of our patients that would have lead to increase risk of active infection ,wound healing problems or skin sloughing. The commoner age group to be affected by fractures is the middle age group, this explained by this age group is the worker and active one ,who most commonly liable for injuries**.** The bone forming capability by the body is more strong and active in young age ,and this explains the earlier appearance of callus the young patients .In open fractures usually there is soft tissue lose and this leads to poor blood supply to fractured area ,this well leads to a more delayed time for callus appearance after the injection. Tibia ,especially the distal part, have poor blood supply ,which make the most liable bone for non union and callus appearance after injection. Connolly et al stated that autologous bone marrow has been most useful for the preventive treatment of non union by early injection of delayed union. He also said that the ideal for bone marrow injection should be after the initial inflammatory and osteoclastic resorption period of fracture has subsided (13).Our finding that 92% of our cases successfully responded to percutaneous bone marrow injections was agreed by Siwach(11). Paley et al stated that marrow produces optimal effect when used early in fracture healing process with the poorest results encountered when used in the treatment of established non union. This agrees with our findings that the earlier bone marrow injection after fracture the best the outcomeis (5).The technique of bone marrow grafting has many advantages in the respect that it can be done under very short time of general anesthesia, there is no soft tissue consideration, it is simple and safe procedure. We further believe that this technique of percutaneous bone marrow grafting really enhance union in cases of delayed union and non union. In addition this is a good procedure for patients with high risk for long time general anesthesia. Moreover there is nothing to be lost even if we fail to achieve union by this simple procedure.

The study reveals another advantage of this procedure that is multiple percutaneous marrow injections can be performed without donor site complications and can be necessary to successfully heal nonunion and delay union.

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