



**PERCUTANEOUS AUTOGENOUS BONE MARROW INJECTION FOR DELAYED UNION
AND NON-UNION OF LONG BONE FRACTURES**

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ABSTRACT

Aim: To evaluate the efficacy of percutaneous autogenous bone marrow injection in delayed union and non union long bone fractures. **Method of data collection:** The study was conducted in the Department of Orthopaedic at Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram. . A sample size consisted of 20 patients with delayed union and non union long bone fractures treated by percutaneous autogenous bone marrow injection during the period from July 2013 to October 2015. The methods of assessment included clinical examination and radiological observation using Schmits staging of fracture healing. **Results:** We observed complete clinical and radiological union in 80% of our study population. The mean time for appearance of callus after percutaneous autogenous bone marrow injection was 5 weeks; for clinical union was 12 weeks and for that of radiological union was 16 weeks. There were no immediate or delayed complications observed during the course of our study. **Conclusion:** Percutaneous autogenous bone marrow injection is a simple, minimally invasive technique in the management of delayed and non-union of long bone fractures which is cost effective to the patient and a potential tool for the treating physician.

Keywords: Delayed union, non-union, percutaneous, bone marrow injection.

1.INTRODUCTION

The advent of high speed vehicles coupled with ever growing traffic and poorer road condition have made high velocity trauma, a common incidence in our daily lives. Complicated fractures have thus become an integral part of orthopaedics practice. Delayed union and non union of long bone fractures are a common complication following high velocity trauma. The limited availability of donor sites for bone grafting especially in paediatric and osteoporotic patients poses, a challenge to the treating orthopaedic surgeon.

Advances in cellular and molecular biology have made the understanding of bone healing better. In the process of bone formation and healing of delayed union and non union of long bone fractures, the bone marrow is a potential and

effective source of osteoprogenitor cells which is the most important factor in this process. Percutaneous autogenous bone marrow injection is a minimally invasive procedure which is a safe, simple, economical and a short duration procedure. This is a day care procedure which is both patients and surgeon friendly and in short, is an easy substitution for a complex problem.

In our study we are reporting the results of percutaneous autogenous bone marrow injection in the treatment of delayed union and non union of long bone fractures and its associated complications.

2.MATERIALS AND METHODS:

The study was conducted in the Department of Orthopaedic surgery at Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram. Patients with delayed union and non union of long bone fractures treated by

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percutaneous bone marrow injection were included in the study. A sample of 20 patients were included in the study done from July 2013 to October 2015. 17 of these patients had sustained injury due to road traffic accidents, 2 due to assault and one fall from height. There were 12 tibia, 5 femur, 2 ulna and 1 humerus fractures. 14 were open and 6 were closed fracture. Primary modalities of treatment prior to delayed union and non union were 7 internal fixation, 5 external fixation and 8 conservative management.

Inclusion Criteria

- Patients with clinical and radiological evidence of delayed union or non-union of long bones.
- Patients with age above 15 years
- Patients available for 3-6 months of follow up

Exclusion Criteria

- Patients with age below 15 years
- Patients with bone marrow diseases such as aplastic anaemia and other blood dyscrasias.
- Patients who are not available for follow up
- Malignancy

Instruments:-

- 14-16 Gauge bone marrow needle.
- 20ml disposable syringes.
- 16-Gauge epidural needle.

Procedure:

The bone marrow injection was performed under local anaesthesia or short acting general anaesthesia. Under the guidance of C-arm image intensifier, two 16 gauge epidural or lumbar puncture needles were inserted through different angles at the fracture site. The bone marrow needle was then introduced into the cancellous part of the iliac crest in between the inner and outer table. The orientation of the needle with the trocar was changed within the substance of the ilium until marrow was aspirated. The procedure was repeated through multiple punctures in multiple directions at the donor site. On random basis aspirate slide were made to confirm bone marrow cells under microscope. The aspirated marrow was injected immediately at the recipient site through the needle already in place^[1].

Both puncture wounds at donor and recipient sites were sealed with tincture benzoin. The average amount of bone marrow aspirate injected was 70 – 100 ml for femur, 50 – 70 ml for tibia, 30 – 50 ml for humerus and 20 – 40 ml for radius and ulna.

The post operative protocol consisted of adequate analgesia and broad spectrum antibiotic cover in indicated cases. Post operatively the recipient limb was observed for any increase in swelling, stretch pain and distal pulses were monitored. It is essentially a day care procedure where patients were discharged on the same day of procedure in uncomplicated cases. The patients in our study group were followed up at 4 weeks interval post bone marrow injection, until clinical and radiological union was achieved. At every follow up visit, the patients were evaluated with case proforma, clinical examination and radiological assessment.



Fig.: Insertion of needle at fracture site.



Fig.: C-Arm guidance – insertion of needle at fracture site

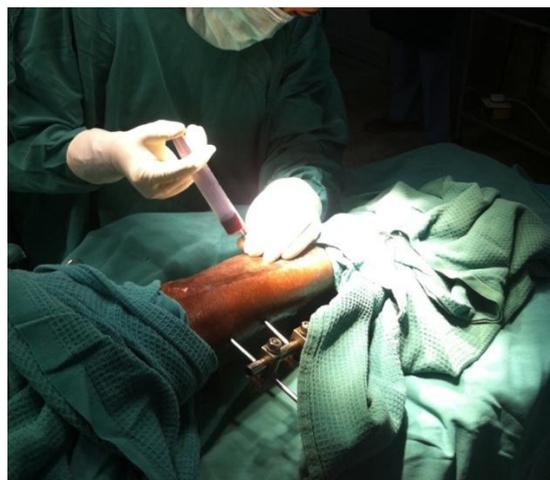


Fig.: Bone marrow aspiration from iliac crest using 16-Gauge needle.

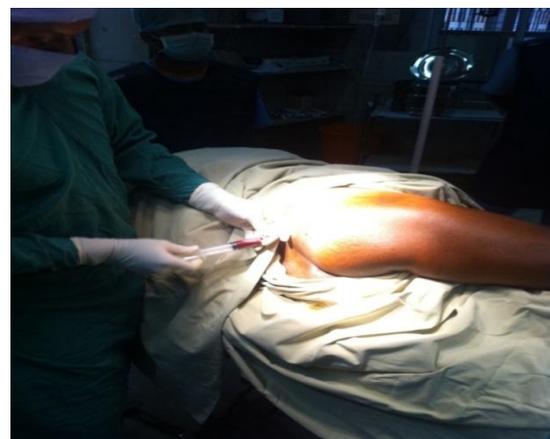


Fig.: Bone marrow injection at fracture site using 16-Gauge needle

3.RESULTS:

We observed in our study population of 20 patients, complete union in 15 cases with delayed union and 1 case with non union of long bone fractures. The rest of our sample population; 2 cases with delayed union and 2 cases with non union of long bone fractures did not show credible evidence of bony union.

The mean time for appearance of callus after percutaneous autogenous bone marrow injection was 5 weeks. The mean time for clinical union after bone marrow injection was 12 weeks with a range of 6 to 16 weeks and for that of radiological union was 16 weeks with a range of 8 to 20 weeks. There were no immediate or delayed complications observed during and after the procedure in our study population with most of the patients being discharged from the hospital on the same day.

TIME DURATION OF CLINICAL UNION AFTER BONE MARROW

TIME DURATION (IN WEEKS)	NUMBER OF CASES	PERCENTAGE
4 – 7	1	6.25
8 – 11	4	25.00
12 – 15	7	43.75
16 – 19	4	25.00
TOTAL	16	100

TIME DURATION OF RADIOLOGICAL UNION AFTER BONE

TIME DURATION	NUMBER OF CASES	PERCENTAGE
4 – 7	Nil	0
8 – 11	1	6.25
12 – 15	4	25.00
16 – 19	6	37.50
20 – 23	5	31.25
24 – 27	Nil	0
TOTAL	16	100

4.DISCUSSION:

Failure of internal fixation or that of conservative management of long bone fractures is any Orthopaedician's nightmare. Surgical complications aside, the conventional treatment methods employed to treat delayed union or non union of long bone has huge implications to the patient in terms of functional, psychological and socio economical effects. The search for newer treatment methods of treating delayed union and non union of long bone fractures, which are minimally invasive with effective functional outcome,

has led to the formulation of percutaneous autogenous bone marrow injection.

The results of percutaneous autogenous bone marrow injection for the treatment of long bone fractures in our study were complete clinical and radiological union in 80% of our study population. The recent clinical studies on percutaneous injections of bone marrow aspirate done by Hernigou P et al^[2], by Braly et al^[3], Ashok K Singh^[4], have achieved successful healing in 75 to 95% of cases which is very well correlated by the results of our study.

It was observed in our study that there was a male preponderance in the distribution of cases. There were a total of 17 males and 3 females in our study group as also had been the case with Shrivastav Rakesh et al^[2]. This can be reasoned out by the higher incidence of male morbidity in high velocity trauma leading to complex fractures and associated complication.

The mean age distribution among patients with delayed and nonunion of long bones in our study was 42 years. This shows that the middle age group is much more commonly affected by delayed and non union of fractures as also observed in the study by Ashok K Singh et al^[4].

In 60% of our study population, the involved bone was tibia and this increased propensity for tibial non union or delayed union among Indian population has also been observed by V Padha et al^[5] (54%) and Iftikhar H Wani et al^[6] (54%) in their respective studies. 58% of tibial afflictions were of distal third involvement. The distal part has poor blood supply and soft tissue coverage which predisposes it more for delayed union and non union.

The majority of patients in our study group had undergone conservative management (40%) as the primary mode of management before bone marrow injection as also been observed by V Padha et al^[5]. Thus it is obvious that there is higher incidence of delayed union and non union by conservative line of treatment in high velocity trauma when compared to internal fixation. 70% of our study population sustained open fractures at the time of initial injury

The average time duration for appearance of callus after bone marrow injection was 5 weeks in our study with a range of 4 to 10 weeks which correlates with the study done by Hernigou P et al^[2] who observed callus between 3 to 8 weeks and that of V Padha et al^[5] in 4.9 weeks. We observed evidence of complete clinical union after bone marrow injection at an average duration of 12 weeks with a range from 6 to 16 weeks and radiological union at an average of 16 weeks. The results are comparable to that of V Padha et al^[5] and Ashok K Singh et al^[4].

There were 4 cases in our study population; 2 delayed union and 2 non union which did not show adequate progression of clinical and radiological union during the course of the study. The reason that could be attributed in these cases are poor soft tissue coverage in open wounds, latent underlying infection, wider fracture gap and poor general medical condition of the patient. We did not encounter any major complication during the course of our study except for pain at the donor site in a very few number of cases, which were managed with analgesia and rest. The limitations of the current study were the small patient number and the absence of laboratory evidence of minimum colony-forming units in the sample used.

CASENO.: 15



BEFORE BONE MARROW INJECTION

CASENO.: 15



12-WEEKS AFTER BONE MARROW INJECTION



BEFORE BONE MARROW INJECTION



20-WEEKS AFTER BONE MARROW INJECTION

5. CONCLUSION

The basis of our study lies in identifying a minimally invasive technique in the treatment of delayed union and non union of long bone fractures. Percutaneous injection virtually eliminates the need to open the fracture site non-union or delayed union cases and prevent the risk of infection or devascularization of the fracture ends, were healing is already impaired. The technique is also simple, minimally invasive, economical and is essentially a day care procedure Thus percutaneous autogenous bone marrow injection is a safe and effective procedure in the

management of delayed and non-union of fracture of long bones without gap at the fracture site.

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