

# Autologous Percutaneous Bone Marrow Injection in Long Bone Fractures with Delayed and Nonunion

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## ABSTRACT

**Objective** To determine the outcome of bone marrow injection in fractures with signs of delayed union and nonunion in terms of clinical and radiological evidence of union.

**Study design** Descriptive case series.

**Place & Duration of study** Department of Orthopedics and Spinal Surgery, Ghurki Trust Teaching Hospital Lahore, from October 2014 to May 2015.

**Methodology** Patients admitted with nonunion or delayed union were included in the study. After evaluation and taking informed consent bone marrow was taken from the iliac crest with the help of bone marrow biopsy needle and injected at the site of fracture with the aid of lumbar puncture (LP) needle under image guidance. Repeat injection was given at three month interval, if needed. Clinical and radiological evidence of bone healing was assessed at six weekly follow ups till six months.

**Results** A total of 80 patients were included. There were 48 males and 32 females. There were 42 tibial, 18 femoral, 11 radius/ulna and 9 humeral fractures. Sixty-two procedures under local anesthesia and eighteen under short sedation were performed. In 67 patients union occurred following injection. The mean healing time was 16 weeks.

**Conclusion** Percutaneous bone marrow injection is an alternative treatment of choice for delayed union and nonunion for long bone fractures.

**Key words** Delayed union, Nonunion, Bone marrow injection, Fractures-long bone.

## INTRODUCTION:

Delayed union and nonunion is a challenging problem.<sup>1,2</sup> In patients with associated vascular injury, rates of delayed and nonunion increases to as high as 46%.<sup>3</sup> Tibia is the most frequently involved bone. Delayed union and nonunion occurs in 50% of open fractures of the tibia.<sup>4,5</sup> The delayed union and nonunion had a great economic impact even in developed countries. Delayed union is when healing

has not advanced at the average rate for the location and type of fracture (usually 3 to 6 months) and nonunion when minimum of nine months elapsed since injury and the fracture shows no visible progressive signs of healing for three months.<sup>3</sup> Both systemic and local factors are responsible for delayed union and nonunion. Successful management of delayed union and nonunion is a challenge for orthopedic surgeons.<sup>1,2</sup> Systemic and local factors should be dealt with properly in the management of delayed union and nonunion.

Condition of skin at site of fracture and neurovascular status of fractured extremity is equally important. Attention should be paid to the soft tissue status as well. Status of bones at fracture site should be assessed and if there is evidence of improper reduction or improper stabilization of fracture fragments then it should be addressed initially to

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achieve bony union of fracture.<sup>4</sup> There are number of methods available for the management of delayed union and nonunion which vary in their invasiveness and outcome. Some methods are noninvasive such as low intensity ultrasound and electrical and electromagnetic stimulation.<sup>3,4</sup> Other methods such as BMP, stem cell therapy and growth factor use are also reported in the management of delayed union and nonunion.<sup>4</sup> Ilizarov is a versatile method for difficult cases.<sup>3</sup>

For many years, the most frequently used method of treatment of nonunion/delayed union has been autogenous open bone grafting.<sup>5,6</sup> Numerous techniques of bone grafting have been described in literature. Open bone grafting, may be associated with various complications such as risk of infection, hematoma formation, ugly scar and interference with fracture site etc.<sup>7,8</sup> To overcome complications and limitations associated with conventional autogenous open bone grafting concept of percutaneous bone marrow injection was introduced.<sup>1,2,7</sup> It is associated with promising results and minimal complications compared with conventional bone grafting. With this procedure there is less risk of surgical and anesthetic complications along with minimal duration of hospital stay.<sup>8,9</sup> This study was conducted to find out how successful autologous bone marrow injection is in patients with delayed and nonunion fractures.

#### METHODOLOGY:

This was a descriptive case series conducted at the Department of Orthopedics and Spine Surgery, Ghurki Trust Teaching Hospital / Lahore Medical and Dental College Lahore, from October 2014 to May 2015 on patients with long bone fractures treated surgically and resulted in either nonunion or signs of delayed union. Patients having infected fractures (pus discharging sinus at the site of fracture) with raised ESR and C reactive proteins (CRP), osteoporotic fractures, pathological fractures, segmental fractures (bone fractured at two places), long bone fractures treated conservatively, fractures less than three or more than nine months old, bleeding disorders, were excluded from the study.

A detailed demographic information, history, examination and biplane radiographs (anteroposterior and lateral projections) of long bone were done after taking informed consent. The procedure was carried out under local anesthesia or sedation. Bone marrow was taken from either anterior or posterior iliac crest with bone marrow biopsy needle. It was injected at fracture site under image control with a LP needle. Aseptic dressing was done at donor and recipient sites and cases

were followed up for a period of six months. The outcome was measured in terms of fracture union clinically and radiologically after bone marrow injection. Patients were discharged on oral analgesics and antibiotics. After the procedure patients were called for follow up at an interval of six weeks for a period of six months. On every follow up clinical evidence of bone healing was assessed. Biplane radiographs were done to observe radiological bone healing. Repeat injections were given after three months if needed. Final assessment for union or failure was done at six months.

The collected data was entered and analyzed by using SPSS version 17. The quantitative variables like age, time taken for union presented as mean and + standard deviation. The qualitative variables like gender and outcome were presented in the form of frequency and percentage.

#### RESULTS:

In this study 80 patients with delayed union/ nonunion of long bone fractures were included. There were 48 (60%) males and 32 (40%) females. Male to female ratio was 1.5:1. Age ranged from 15 year to 60 year. Most of the patients were in the age group of 46-60 year (n =40, 50%) followed by 31-45 year (n =22, 27.5%). In 42 (52.5%) patients tibia was involved (table I). In 62 (77.5%) patients procedure was done under local anesthesia and in 18 (22.5%) under short sedation. In 55 (68.75%) patients injection was given only once and in 25 (31.25%) second injection was given at 3 month interval. There were 47 (58.75%) patients of delayed union and 33 (41.25%) of nonunion.

In 67 (83.75%) patients union was achieved at the end of 6 months follow up and in 13 patients (16.25%) union could not be achieved at end of 6 months follow up. These patients required another procedure either open bone grafting or revision surgery. Union rate was 87.88% in delayed union and 78.72% in nonunion.

**Table I: Frequency of Bone Involved**

Bone Involved	Number (n)	Percentage
Tibia	42	52.5
Femur	18	22.5
Radius/ulna	11	13.75
Humerus	09	11.25
Total	80	100.00

#### DISCUSSION:

Delayed union and nonunion are major concern for

orthopedic surgeons in the management of fracture. Bone grafting has major role in the treatment of nonunion and delayed union of long bone fractures. This is because bone graft has osteoinductive and osteoconductive properties which accelerates the process of fracture healing. Open autogenous grafting technique is very useful but it has some disadvantages such as donor site morbidity and some limitations such as soft tissue consideration at site of fracture. In addition open bone grafting is carried out in general / spinal anesthesia rendering patients to anesthesia risk.

Various scientists evaluated properties of bone marrow and found that it has osteoprogenitor cells, which are capable of inducing callus formation at the site of fracture. Various studies are available in literature where which percutaneous bone marrow injection was given at the site of delayed union and nonunion.<sup>7,10-12</sup> In our study patients between 15-60 years with a mean age of 38±12.06 year were included. This is almost similar to another study where mean age was 36.43 ± 11.04 year.<sup>13</sup> In our study 52.55% patients had tibia involvement followed by femur (13.75%). In a study by Rakesh et al tibia was involved in majority (89.29%) of cases while femur was affected in only 7.14%.<sup>11</sup>

In the present study, union was achieved in 67 (83.75%) patients. The mean healing time was 16 weeks (range 12-20 weeks). Union rate was high in patients with delayed union (90.91%) as compared to patients with nonunion (78.72%). The mean healing time in delayed union was 12 weeks (range 7-14 weeks) while in non union it was 20 weeks (range 15-24 weeks). In Braly et al study healing occurred in 81.82% of patients in 6 months which is lower than our study while in Akram et al study 92% patients showed union and the mean time of healing was 15 ±2.73weeks (range: 12-22 weeks) which is higher than our study.<sup>9,14</sup>

A study conducted by Garg et al in which they grafted autogenous bone marrow percutaneously to stimulate healing in 20 long bone fractures with nonunion. About 15-20 ml of bone marrow was injected twice, with an interval of 3 weeks. Out of twenty, 17 cases achieved bony union in 5 (range 3-7) months.<sup>15</sup> In a study by Ma JT et al the mean union time was 4.5 months (range 3-8 months). They used 3 injections with one month interval. They concluded that if the gap is more than 5 mm or there is mal-alignment then this therapy is not adequate.<sup>16</sup> Li Y et al used interlocking nail with bone marrow injection for nonunion of humerus and the union was observed in 100% cases with mean time of 4.5 months.<sup>17</sup>

Percutaneous bone marrow injection had gained popularity in recent years as it has many advantages over conventional bone grafting. Moreover this procedure can be done on out-patient basis. There is nothing to loose with this procedure as conventional bone marrow grafting can be done after percutaneous bone marrow injection if there is insufficient clinical and radiological evidence of union. In this study second procedure (open bone grafting or revision surgery) was required in patients when delayed union / nonunion persisted.

#### CONCLUSIONS:

Percutaneous bone marrow injection can be used as an alternative to open grafting in delayed and nonunion cases with acceptable results. It is minimally invasive and can be carried out either under local anesthesia or sedation.

#### REFERENCES:

1. Nandi SK, Roy S, Mukherjee P, Kundu B, Kundu B, De DK, Basu D. Orthopaedic applications of graft & graft substitutes: a review. *Indian J Med Res* 2010;132:15-30.
2. Wani IH, Padha V, Jan M, Salaria AQ. Percutaneous bone marrow grafting in delayed union and on-union. *Int J Med Sci*. 2013;5110-5.
3. Canale ST, Beaty JS. Delayed union and nonunion of fractures. *Campbell's Operative Orthopaedics*. 11th ed. New York: Elsevier; 2012:3018-86.
4. Zimmermann G, Moghaddam A. Trauma: nonunion new trends. G. Bentley (ed.), *European Instructional Lectures*. European Instructional Lectures 10. DOI: 10.1007/978-3-642-11832-6\_2, © 2010 EFORT.
5. Sprague S, Bhandari M. An economic evaluation of early versus delayed operative treatment in patients with closed tibial shaft fractures. *Arch Orthop Trauma Surg*. 2002;122:315–23.
6. Friedlaender GE, Perry CR, Cole JD, Cook SD, Cierny G, Muschler GF, et al. Osteogenic protein-1 (bone morphogenetic protein-7) in the treatment of tibial nonunion. *J Bone Joint Surg Am*. 2001;83S:151-8.
7. Kassem MS. Percutaneous autogenous bone marrow injection for delayed union or

- nonunion of fractures after internal fixation. *Acta Orthop Belg.* 2013;79:711-7.
8. Ebraheim NA, Elgafy H, Xu R. Bone graft harvesting from iliac and fibular donor sites: techniques and complications. *J Am Acad Orthop Surg.* 2001;9:210-8.
9. Braly HL, O'Connor DP, Brinke MR. Percutaneous Autologous bone marrow injection in the treatment of distal metaphyseal tibial nonunions and delayed unions. *J Orthop Trauma.* 2013;27:533-4.
10. Shah FA, Khan Z, Durrani ZA, Ismatullah, Kifayatullah, Khan H. Role of percutaneous autologous bone marrow grafting in non-union tibia, *J Surg Pakistan.* 2010;18:92-6.
11. Rakesh DS, Sapolia DA, W DGB, Parmar DSM. Percutaneous autologous bone marrow injection in the treatment of delayed and non-union of long bones. *NJIRM.* 2013;4:39-43.
12. Hernigou P, Mathieu G, Pognard A, Manicom O, Beaujean F, Rouard H. Percutaneous autologous bone-marrow grafting for nonunion. *Surgical technique, J Bone Joint Surg Am.* 2006;88:322-7.
13. Bhutia KU, Bary AA, Singh AK, Singh AM, Raghuvanshi R, Hmar C. Role of percutaneous autologous bone marrow injection in treatment of delayed union and non union of long bones. *IOSR-JDMS.* 2015; 14:7-13.
14. Akram M, Irshad M, Farooqi FM, Sah RK, Shahzad ML, Sarfraz AH, et al. Role of injecting bone marrow aspiration injection in treating delayed union and non-union, *J Pak Med Assoc.* 2014;64:12:154-7.
15. Garg NK, Gaur S, Sharma S. Percutaneous autogenous bone marrow grafting in 20 cases of ununited fracture. *Acta Orthop Scand.* 1993;64:671-2.
16. Ma JT, Yu M, Zhang MC, Zhu XJ, Xu HY, Liang GJ. Clinical observation on percutaneous autologous bone marrow grafting for treatment of fracture nonunion. *Zhongguo Gu Shang.* 2009;22:862-4.
17. Li Y, Shi S, Liu Z, Li Z, Wang R, Guo Y, Chang H. Treatment of humeral shaft nonunion with interlocking nail and percutaneous injection of bone marrow, *Zhonghua Wai Ke Za Zhi.* 2000;38:732-5.

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