TREATMENT OF TIBIAL NONUNION AND DELAYED UNION BY PERCUTANEOUS INJECTION OF CONCENTRATED AUTOLOGOUS STEM CELLS: AN ALTERNATIVE TO OPEN SURGICAL REPAIR – A CASE REPORT

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CASE HISTORY:

A 49 YO non-smoking female with celiac disease sustained bilateral spiral oblique tibia fractures while skiing. Initial treatment involved intramedullary fixation.

Fig. 1

Seven months post-injury, patient still reports bilateral leg pain (R>L). X-rays showed delayed union in the left tibia with minimal callus formation (Radiograph: Figure 1) while the right tibia showed no evidence of callus formation and a large anterior fracture gap. Open surgical repair with exchange nailing was offered but the patient preferred less invasive options. Patient has used an external bone growth stimulator for three months with no significant change.

TREATMENT OPTIONS:

1. Reamed exchange nailing.
2. Open reduction and internal fixation (ORIF) after take-down of nonunion and iliac crest or other autologous bone graft.
3. Percutaneous injection of concentrated autologous stem cells from bone marrow aspirate concentrate.

TREATMENT PLAN:

At six months post-injury the patient has a delayed union of the left tibia and a nonunion of the right tibia, with persistent pain and a reluctance to open surgical repair. Since the patient was a non-smoker, satisfactory nutritional status, and had reasonable expectations, with skin and local tissues in good condition and adequate limb alignment, the decision was made to pursue the least invasive intervention.

Bone marrow taken from the iliac crest was concentrated to produce a high dose of autologous stem cells (bone marrow aspirate concentrate - BMAC) and was percutaneously injected into the tibial fracture nonunion sites. This treatment modality has been shown to heal tibial nonunions[1]. Efficacy appears to be related to the total number of progenitor cells delivered to the nonunion site. In healing impaired patients, bone marrow aspirate alone or with inadequate concentration[1,2,3,4], is not as therapeutically effective as BMAC due to lower numbers of progenitor cells delivered to the fracture site.

MATERIALS AND METHODS:

After prepping the bone marrow aspiration kit components and following General Anesthesia, a single incision was made 2cm posterior to the anterior superior iliac spine on each iliac crest.

An 11g multiport bone marrow aspiration needle with stylet in place was introduced at the superior aspect of the iliac crest. The needle was advanced 4 to 6 cm into the bone cavity. The stylet was removed and an aspiration syringe was attached to the hub of the needle. Marrow was aspirated by short quick pulls on the syringe which allowed 4 to 5 mL marrow to be aspirated for each pull on the syringe. The needle was withdrawn approximately 2 cm and rotated 90 degrees and the previous step repeated. When the syringe

contained approximately 15 mL of marrow, the syringe was removed from the needle and the marrow was injected into a sterile blood bag containing an anticoagulant. These steps were repeated (two iliac crest needle punctures) until ±120 mL of bone marrow was harvested. The total bone marrow aspiration time was approximately 15 minutes.

The bone marrow was then placed into the SmartPReP BMAC (Harvest Technologies Corp. Plymouth, MA) disposable containers for processing. Approximately 15 minutes later, 20 mL of bone marrow aspirate concentrate was available for injection.

An 18g needle was used to percutaneously inject BMAC into and surrounding the fracture nonunion sites, using fluoroscopy to verify needle placement. The patient tolerated both the bone marrow aspiration and the BMAC injections well.

Following surgery, the patient was instructed to remain non-weight bearing for 4 weeks and remained immobilized in removable short leg boots.

RESULTS:

During follow-up visits, patient reported less pain. Palpation of the anterior right tibia produced some tenderness. Good range of motion was present in the knee and ankle. X-rays obtained four weeks later show consolidation of the left tibia and significant new callus formation of the right tibia.

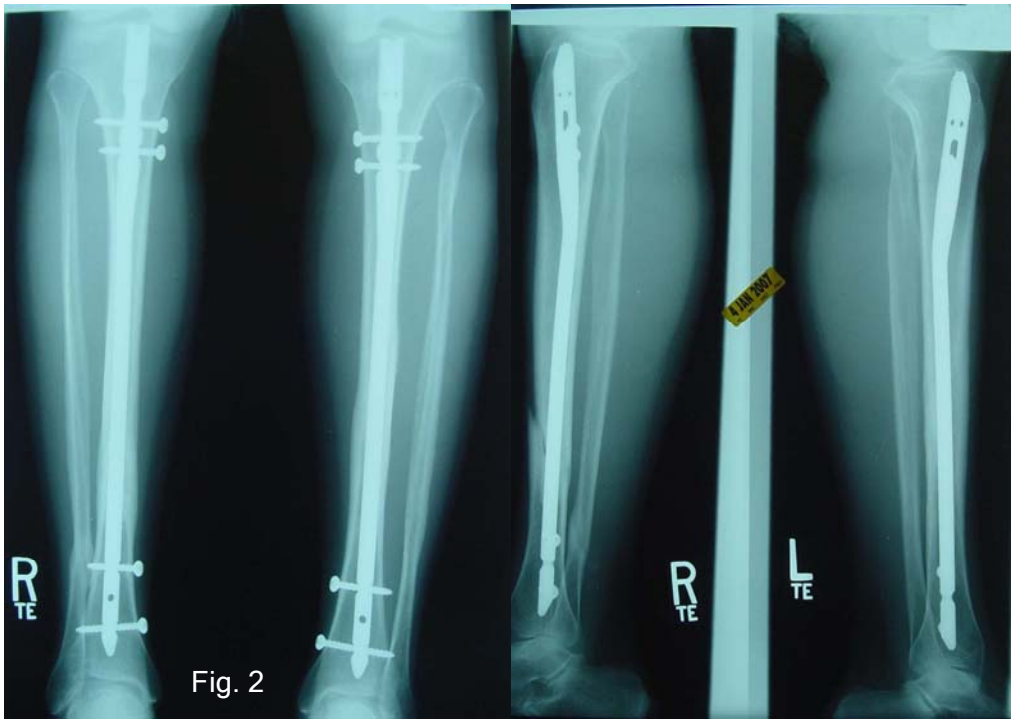

Fig. 2

Upon further follow-up 4 weeks later (eight weeks post BMAC treatment), patient reports minimal pain. X-rays show right tibia has healed, although a spike of bone has interposed fibrous tissue that continues to heal but with no clinical symptoms (Radiograph: Figure 2). The patient has now returned to unlimited activity.

CONCLUSION:

It has been widely reported by Connolly, Gangji[5], Hernigou and others that percutaneous delivery of a high concentration of adult stem cells can enhance the rate and amount of bone formation. In my experience, the Harvest BMAC™ system (bone marrow aspirate concentrate), has allowed me to quickly and effectively produce a therapeutic dose of adult stem cells at the patient bedside that resulted in improved healing. Percutaneous injection of high dose stem cells may offer the surgeon and patient a new therapeutic option when treating troublesome nonunions or delayed healing fractures.

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1 Hernigou P, Mathieu G, Poignard A, Manicom O, Beaujean F, Rouard H.; Percutaneous autologous bone-marrow grafting for nonunions. Surgical Technique. J Bone Joint Surg Am. 2006 Sep;88 Suppl 1 Pt 2:322-7

2 Hernigou, P, et al, Percutaneous Autologous Bone-Marrow Grafting for Nonunions: Influence of the Number and Concentration of Progenitor Cells, *Journal of Bone and Joint Surgery,* 2005; 87-A; 1430-1437

3 Lieberman JR, Commentary & Perspective on "Percutaneous Autologous Bone Marrow Grafting for Nonunions" by Hernigou P et al, *Journal of Bone and Joint Surgery,* 2005; 87-A; 1430-1437; e*JBJS, July 2005*

4 Connolly, JF, et al, Development of an Osteogenic Bone-Marrow Preparation, *Journal of Bone and Joint Surgery*, June 1989; 684-691

5 Gangji et al Treatment of Osteonecrosis of the Femoral Head with Implantation of Autologous Bone-Marrow Cells. *Journal of Bone and Joint Surgery,* 2004 June N6; 86-A; 1153-1160

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