

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

This research **establishes the need for concentrating bone marrow aspirate**. The study evaluated the number and concentration of progenitor cells that were transplanted for the treatment/repair of nonunion, the callus volume obtained after the transplantation, and the clinical healing rate.

**Methods**

- 60 noninfected atrophic nonunions of the tibia
  - Twenty (28) patients had comorbidities: 15 history of tobacco use, 8 history of alcohol abuse, 3 had diabetes, 2 had use a pharmaceutical agent affecting bone marrow physiology
  - 17 fractures were in proximal, 12 were in distal, and 31 were in midpart of tibial shaft.
  - 312 ml of bone marrow aspirate was concentrated using a cell saver system to a volume of 50 mL. A mean of 20 cm<sup>3</sup> of bone marrow graft was injected into each nonunion site.
  - The number of progenitor cells transplanted was estimated by counting the fibroblast colony-forming units

**Results**

- Overall, bone union was achieved in 53 of the 60 patients for an 88.3% fusion rate.
  - Patients achieving bone union avoided surgical intervention (with internal and/or external fixation).
  - Bone union was achieved 53 of 53 patients for a 100% fusion rate for those patients receiving concentrated bone marrow aspirate.
  - Bone union failed in 7 of 7 patients in those patients receiving unconcentrated bone marrow aspirate.
- Age, sex, and comorbidities of patients did not significantly affect the success of treatment (p<0.05).
- Bone marrow aspirate data

	<b>Full Healing (n=53)</b>	<b>Non-Healing (n=7)</b>	<b>BMAC™ Comparison</b>
Bone Marrow Aspirate, ml	306 ± 24	306 ± 24	120 ± 2
Unconcentrated BMA, Progenitors/cm <sup>3</sup>	612 ± 134	612 ± 134	≅ 485
Concentration of Progenitors/cm <sup>3</sup> in Graft	2,835 ± 1,160	634 ± 187	2,900 ± 598
Increase Above Baseline	4.6x	1.0x	6.0x
All grafts contained Progenitors/cm <sup>3</sup>	> 1500/cm <sup>3</sup>	< 1000/cm <sup>3</sup>	

**Conclusions/Key Points**

- Percutaneous autologous BMA grafting is an effective and safe method for the treatment of atrophic tibial diaphyseal nonunion.
- Efficacy appears to be related to the number of progenitors in the graft
- Since all patients had the progenitor cells, the wide variance between the healing/non-healing progenitor cell counts is a function of the processing system and its inability to produce a consistent end product.
- Dr. Hernigou has reported treating an additional 700 patients with this protocol and achieved similar results.