Resolving a Distal Tibia Non-union: A Case Study on the Use of Growth Factors from Autologous Platelet Rich Plasma (PRP)

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Background

Autologous bone grafts are often used for surgical treatment of orthopaedic non-unions or to assist in the surgical creation of bony fusions.[1-3] Some common drawbacks to autologous grafts are the limited quantity of graft material and graft quality. Platelet concentrates, also known as platelet rich plasma (PRP), offer a reasonable biologic augmentation to autologous bone graft material, are easy to create, contain elevated levels of platelets and are a source of high levels of growth factors. [4-6]

Platelet concentrates are not entirely new to medicine; in the past they were most often used for diagnostic testing and during cardiac surgeries. In the 1940s and '50s, whole blood began to be separated into its components: red blood cells, platelets and plasma. Potentially three patients could be treated with one unit of donated blood. In the mid-1980s, cardiac bypass patients began donating two units of their own blood before surgery. Since these patients were placed on heart-lung machines, which damage platelets, cell salvage machines were used on the presurgery blood donations to bank healthy platelets. After surgery, the PRP was transfused back into the patient to stop bleeding. After a decade of this practice, as cardiac surgeons and bypass machines were becoming more effective, a patient's platelets were less likely to be damaged. The question became, "What to do with the PRP?" A resourceful anesthesiologist, considering the properties of PRP, began to combine the PRP with thrombin and calcium chloride, and to apply the mixture to surgical wounds. Spinal surgeons, accustomed to long surgeries involving significant bleeding and bone grafting, became interested in platelet concentrates. They discovered that by combining PRP with bone graft materials one can achieve improved graft handling properties and improved healing.

Platelet concentrate for orthopaedic application is quickly and easily prepared intraoperatively using Symphony™ PCS (DePuy Orthopaedics, Warsaw, Indiana. During surgery, a small amount of the patient's blood is drawn and then placed in a specially designed container. After the container is centrifuged, PRP can be removed for surgical use. The whole process takes roughly 15-20 minutes. PRP containing four to six times the native platelet levels is high in growth factors. The system is automated and has a minimal number of operator steps which minimizes any risk of contamination during the processing steps.

Research has shown increased bone healing rates, decreased need for narcotics, and improved biomechanical performance when platelet concentrates are employed in orthopaedic situations.[1,2,7,8]

Case Study

Diagnosis and Early Operative Treatments

The patient is a 38-year-old female with a history of Type II diabetes. She slipped and fell on ice and fractured her tibia and fibula. The distal metaphyseal tibia fracture was fixed percutaneously with cancellous screws and an external fixator. The associated distal third fibula fracture underwent open reduction and internal fixation with plates and screws; a posterior butterfly fragment could not be reduced; the resulting gap was packed with AlloMatrix® bone matrix (Wright Medical). Sixteen days post-injury the patient's injured leg was placed in a cast. An early callus was identified on a follow-up radiograph and the patient began a four-week weaning from crutches *(Figure 1)*.

At seven months post-injury, the patient was playing tennis

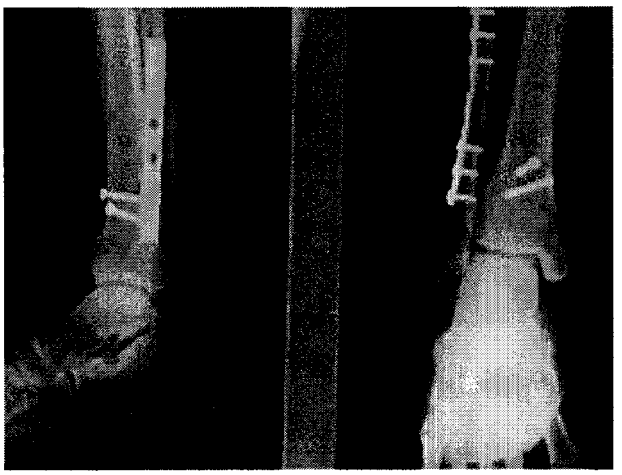

Figure 1: One month post-op (first operative treatment)

and developed an aching pain at the tibia fracture site. Follow up radiographs showed a non-union with a broken screw and hypertrophic callus formation. A bone stimulator was employed for five months to heal the non-union; a tomogram at one year post-injury confirmed the continued existence of non-union *(Figure 2)*.

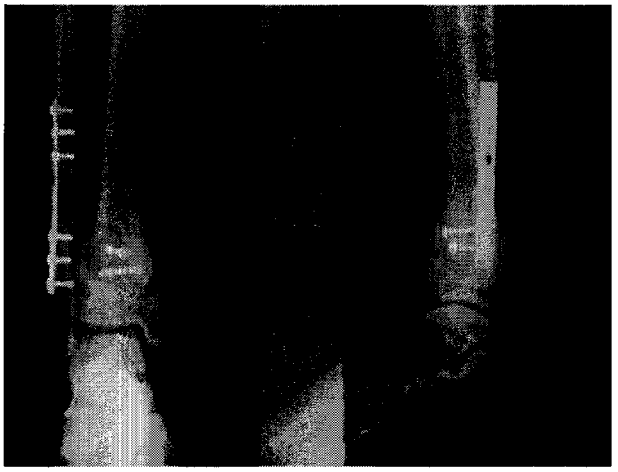

Figure 2: One year post-op (first operative treatment)

Operative Treatment with PRP

Thirteen months after the initial injury, the patient again underwent surgery; this time to repair the non-union. The patient was given general anesthetic and one gram of Ancef (Cefazolin) intravenously. A tourniquet was applied to control hemostasis in the surgical field. The non-union was approached using an anteromedial incision over the distal tibial fracture and subperiosteal exposure was achieved. The non-union fibrous tissues were completely removed with rongeur and curettes resulting in a bed of healthy bone. The fracture was stabilized with a DePuy ACE titanium distal tibia plate. The resulting bony defect was packed with intraoperatively harvested iliac crest bone graft and mixed with PRP prepared using the Symphony PCS. Closure included periosteal closure over the tibial plate using #1 vicryl sutures and staples to close the skin. The patient left the hospital one day after surgery.

Clinical Outcome

At one week, the staples were removed and the patient was put in a boot, non-weight bearing for six weeks. From six to ten weeks post-surgery the patient was weaned off the crutches; and good radiographic progression toward union was observed *(Figure 3)*. At ten weeks after surgery, the patient was pain free with normal gait. There were radiographic signs of healing and early cortication of the bone graft material *(Figure 4)*. The most recent follow up at ten months postoperative, the patient continues to be pain free with normal gait; in addition, the patient has resumed playing tennis. There is no loosening of the plates and screws and radiographic examination shows continued filling of the prior defect with bone. The patient has been declared clinically and radiographically healed *(Figure 5)*.

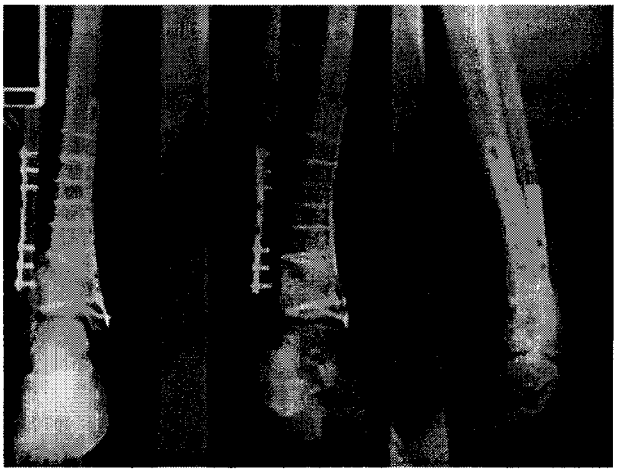

Figure 3: One month post-op (second operative treatment)

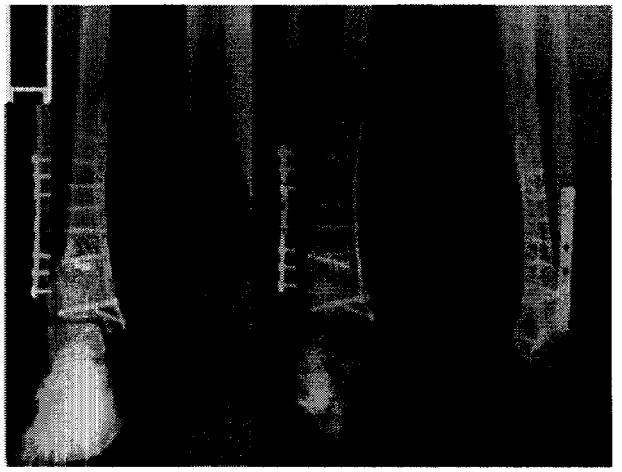

Figure 4: Ten weeks post-op (second operative treatment)

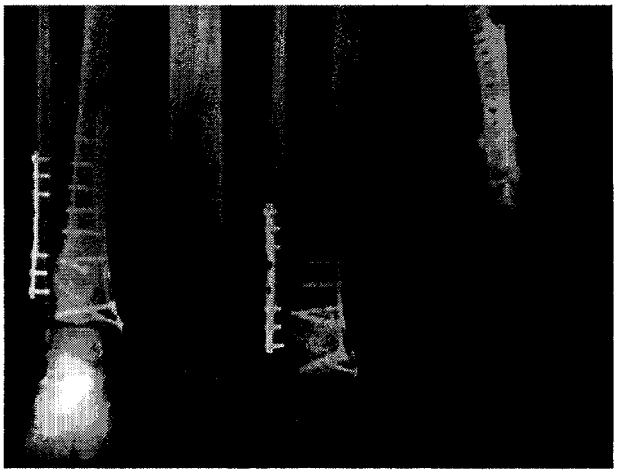

Figure 5: Ten months post-op (second operative treatment)

Conclusion:

Platelet concentrates offer bone healing advantages when platelets release a variety of growth factors from their alpha granules, including transforming growth factor-β (TGF-β), platelet derived growth factor (PDGF), vascular endothelial growth factor (VEGF) and epidermal growth factor (EGF). The growth factors in turn initiate the wound healing cascade and promote osteoblast/osteoprogenitor proliferation. Research has shown that growth factors have a greater effect on osteogenic cell proliferation when available as a combination or a "cocktail of growth factors."[7,9] PRP concentrates, combined with bone-grafting materials, have significant potential for the treatment of fracture non-unions.

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