Platelet Rich Plasma (PRP) Supplementation for Phalangeal Pseudoarthrosis Treatment: A preliminary case report

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Citation

S Nishimoto, T Oyama, T Tsugawa, N Toda. *Platelet Rich Plasma (PRP) Supplementation for Phalangeal Pseudoarthrosis Treatment: A preliminary case report*. The Internet Journal of Plastic Surgery. 2006 Volume 4 Number 2.

Abstract

Pseudoarthrosis is rare. Though, when it occurs, lots of efforts are required to cure. Platelet rich plasma (PRP), concentrated from blood, have attracted attention as a good source of growth factors that stimulate cells to proliferate, migrate and restore the damaged sites. Two cases of acquired pseudoarthrosis were successfully treated with PRP, produced from the patients' own peripheral blood or bone marrow aspirate, in conjunction with external fixation. Bone union was obtained in both cases. We present these cases as a preliminary report.

PATIENTS AND TREATMENT

PROCESSING PLATELET RICH PLASMA

PRP was produced under the protocol, optimized previously in authors' Department for the clinical use of PRP.[1] Under general anesthesia, peripheral blood or bone marrow aspirate was drawn into 20-ml syringes containing 3ml of anticoagulant; citrate-phosphate-dextrose solution (Terumo, Tokyo, Japan), prior to the surgery. After gentle inverting mixture, the mixture was poured into 10-ml tubes with caps. The tubes were set in a centrifuge separator placed besides the operating table and spun at 40g for 20 minutes. Supernatant, including buffy coat and slightly red layer, was decanted to the other tubes. Platelets and other cells are spun down at 800g for 10 minutes. Clear supernatant was decanted off and precipitate was resuspended to get PRP. Approximately, $1x10^9$/ml platelets and $2x10^7$/ml white blood cells were contained in peripheral blood derived PRP. $1x10^9$/ml platelets and $6x10^7$/ml nucleated cells were contained in bone marrow aspirate derived PRP.

CASE 1

A nine–year-old girl presented with bifid thumb of her right hand. She underwent excision of radial element and closing wedge osteotomy on the proximal phalanx of remaining thumb to correct alignment. A stainless steel carpal wire was placed as an intramedullary nail. The periosteum was approximated with an absorbable thread. The abductor pollicis brevis muscle was reattached. The first post-operative week was uneventful and she was discharged. Non-union was observed at the osteotomized phalanx during following up period. (Figure 1 Left) She complained pain in the thumb. Splinting was continued, but in vain. Three months after the initial surgery, revisional surgery was carried out. The non-union site was surgically refreshed and external fixation device was applied. One ml of PRP, processed from 20ml of the patient's peripheral blood, was applied to the site. Bony union was observed after 4weeks and the external fixation device was taken off. (Figure 1 Right)

Figure 1: (Left) Radiograph showing non-union site on osteotomized proximal phalanx of right thumb. (Right) Radiograph showing bony union, three months after the revisional surgery with application of PRP.

CASE 2

A twelve-year-old girl, diagnosed as Poland's syndrome, had a hypoplastic left hand. She has undergone surgeries to release interdigital web spaces. Her fingers were thin and short. She experienced successful distraction osteogenesis of her middle finger. She also wanted her index finger elongated. Osteotomy of her thin phalanx was done and a distracter was applied. 15 mm distraction was successfully carried out. The distraction device was taken off after 6 weeks consolidation period. One week after, she broke the phalanx at the site of bony hole, where the fixation pin of the device had been placed. A splint bandage was done, but bony union was not seen (Figure 2 Left). The non-union site was surgically refreshed and external fixation device was applied. PRP, obtained from her iliac bone marrow aspirate,

was applied with particles of cancerous bone taken from her iliac diploe. Bony union was observed after 6 weeks fixation (Figure 2 Right).

Figure 2: (Left) Radiograph showing non-union site on elongated phalanx. (Right) Bony union was obtained five months after bone grafting with PRP derived from bone marrow aspirate.

DISCUSSION

Platelets play great rolls in repairing damaged tissue. When a vessel is broken, sub-endothelial collagen is exposed. Then, platelets adhere to the collagen and are activated to release the contents of granules, which trigger coagulation cascades. Platelets also release various growth factors from alpha-granules to signal the site of damage and to activate cells in surrounding tissue to restore the site. Platelet derived growth factor (PDGF), transforming growth factor-beta (TGF-beta), vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), Insulin-like growth factor (IGF) and so on are nominated as contained growth factors,[2, 3] and the effects of them have been studied both in vitro[4, 5] and in vivo.[1, 6, 7, 8]

Platelet rich plasma (PRP), concentrated from blood, have attracted attention as a good source of growth factors. In orthodontic field, clinical applications are widely done in daily practice. Authors experienced positive effect of PRP in alveolar bone grafting for cleft patients.[1] When it is processed from the patient's autologous blood, potential hazard is low. It is cost-effective, because processing cost is very low.

Pseudoarthrosis happens not so often, but when it occurs, lots of efforts are required to cure. Sometimes, successive operations are demanded. The more revisions are done, the shorter the bone length will be. Causes of non-union vary. They are inadequate fixation, inadequate vascular supply to the fractured site, infection and so on. To treat pseudoarthrosis, elimination of these factors has to be done surely. Debridement of non-union site has to be done. Edges of refreshed bone surface have to be approximated finely. In addition to these procedures, supplying growth factors may help bone formation. Growth factors are expected to stimulate osteoblasts to proliferate, migrate to the bony gap and restore the site. They are expected to induce angiogenesis of surrounding tissue and regenerated bone. Although, osteoconductive ability of PRP has been confirmed,[9] osteoinductive ability has been denied.[10] PRP is speculated to accelerate mainly early phase of bone healing, by increasing material cells. Developments of those cells to bony or vascular cells are induced by the environment.

The authors have concentrated bone marrow aspirate under the same protocol to produce PRP from peripheral blood.[11] The authors call the concentrate “bm-PRP”. The authors have confirmed that “bm-PRP” contains the same number of platelets and the same level of growth factors as PRP. We also confirmed that “bm-PRP” contains concentrated bone marrow stromal cells including so-called stem cells.[12] Growth factors and working cells can be concentrated simultaneously by a simple technique. We have been able to generate alveolar bone by implanting beta tri-calcium phosphate granules soaked with “bm-PRP” without bone grafting.[11] This “bm-PRP” may be theoretically better than PRP from peripheral blood, to treat pseudoarthrosis.

Two cases of pseudoarthrosis were treated successfully with PRP in conjunction with external fixation. This is the first report of PRP application for phalangeal pseudoarthrosis. These cases are young and healthy individuals. It is not easy to prove efficacy of PRP in treating pseudoarthrosis without randomized control study. But, it can be theoretically expected that PRP plays a great roll in treating pseudoarthrosis.

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