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Topical administration of platelet rich plasma during distraction osteogenesis – a preliminary result of four cases

Distraction osteogenesis is a perfect method for limb lengthening in patients with limb length discrepancy, limb axis corrections or large bone defect caused by tumor, infection, or trauma. This treatment method has many advantages, but the periods of external fixation and bone maturation is long. This may result in higher rates of complications such as joint contractures, pin track infection, delayed consolidations, pin loosening and fractures (6). Decreasing the treatment period by accelerating bone formation and tissue remodelling could reduce these complications. Platelet-rich plasma (PRP) as an autologous concentration of human platelets in a small volume of plasma is a concentration of the 9 fundamental protein growth factors proved to be actively secreted by platelets to initiate all wound healing. (Fig. 1A and 1B).

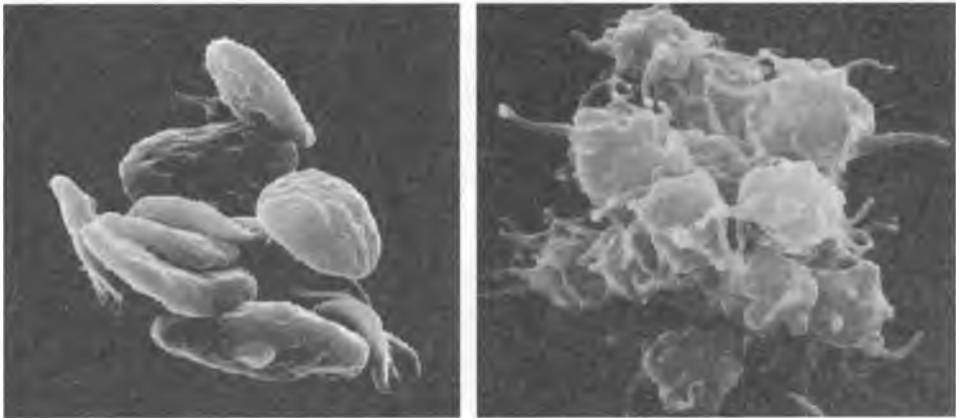


Fig.1. Platelet cells in scanning microscopy (A), activated platelet cells (B)

These growth factors include the 3 isomers of platelet-derived growth factor (PDGF $\alpha\alpha$, PDGF $\alpha\beta$, and PDGF $\beta\beta$), 2 of the numerous transforming growth factors- β (TGF β 1 and TGF β 2), vascular endothelial growth factor, insulin-like growth factors (IGF-I, IGF-II) and epithelial growth factor. All of these growth factors have been documented to exist in platelets (2,4). PRP as an autogenous source of growth factor has been shown to stimulate osteoblast-like cells in vitro and to enhance bone graft incorporation in maxillofacial applications in vivo (5). PRP has also been shown to promote early maturation of bony fusion and has yielded good fusion results in lumbar spine fusions clinically (3).

The aim of the study was developing a method to enable acceleration of bone formation during limb lengthening using topically intra regenerate injected PRP.

PATIENTS AND METHODS

After Medical University of Lublin human studies committee four limb lengthening procedures with PRP administration were performed in four patients at the Children Orthopedic Department of Medical University of Lublin. Two femoral and two tibial lengthenings were done in four patients because of congenital limb length discrepancy (three limbs), and secondary to inflammation (one limb). All patients were followed up until removal of the pins.

SURGICAL PROCEDURES

Before the osteotomy, the Orthofix monolateral fixator was placed on the lateral aspect of the femur and the Ilizarov apparatus on the tibia. Percutaneous osteotomy was performed in the diaphyseal region in each bone.

PREPARATION OF AUTOLOGOUS PRP

PRP was extracted immediately prior to application. In three cases we produced PRP using Curasans system PRP kit. 8.5ml of citrated blood (8.5-ml ACD vacutainer) was centrifuged in a standard laboratory centrifuge for 10min at 2400r.p.m. This procedure divides the blood into three basic components red blood cells, PRP and platelet poor plasma (PPP). The red blood cell layer forms at the lowest level, the PRP layer in the middle and the PPP layer at the top. PRP and PPP are drawn off with a second monovette, which is then placed in the centrifuge. The second spin is done at 3600r.p.m. for 15min. The platelet pellet accumulates at the bottom of the monovette, the PPP on top. The PPP is drawn off so that the PRP remain in the monovette. After resuspending the platelet pellet within the remaining volume of plasma with the vortex mixer, the platelet concentrate can be drawn up with a syringe for use. In last patient we extracted PRP using automated, closed Magellan system (Medtronic). From 30 ml of citrated blood we obtained 3 ml of PRP.

RESULTS

And after PRP instillation, following radiographs of all four patients represent significant acceleration of bone formation. The target lengths were obtained in every segment without major problems. In all children, after lengthening phase, PRP application was done into site of the regenerate. (Figs. 2, 3 and 4).

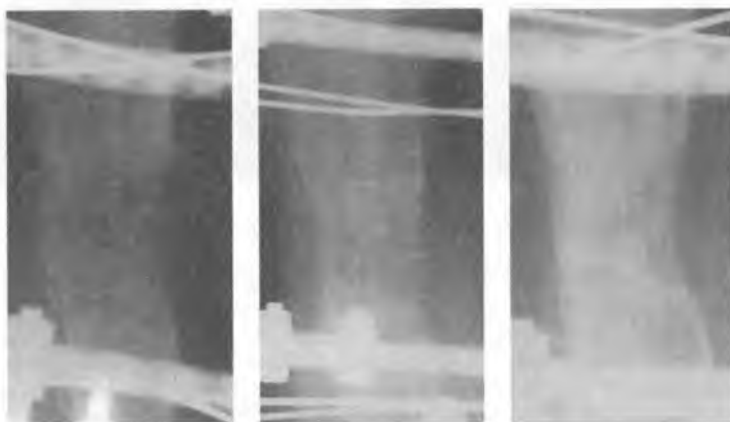


Fig. 2. Radiographs of the left tibia of 14 years old girl. Before the first application of PRP (A), 5 weeks later after (B), and 11 weeks after application of PRP (C). Callus formation was satisfactory during the lengthening period

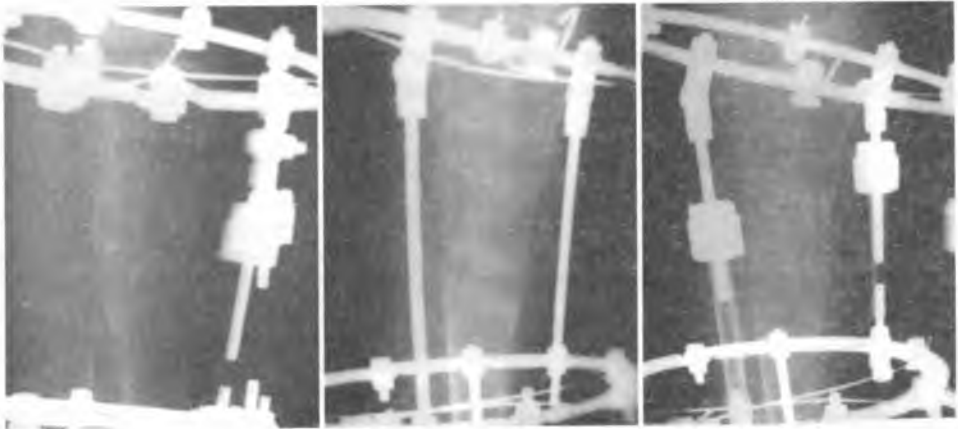


Fig. 3. Radiographs of the right femur of 14 years old boy. Before the first application of PRP (A), 3 weeks later after (B), and 7 weeks after application of PRP (C). Callus formation was satisfactory during the lengthening period

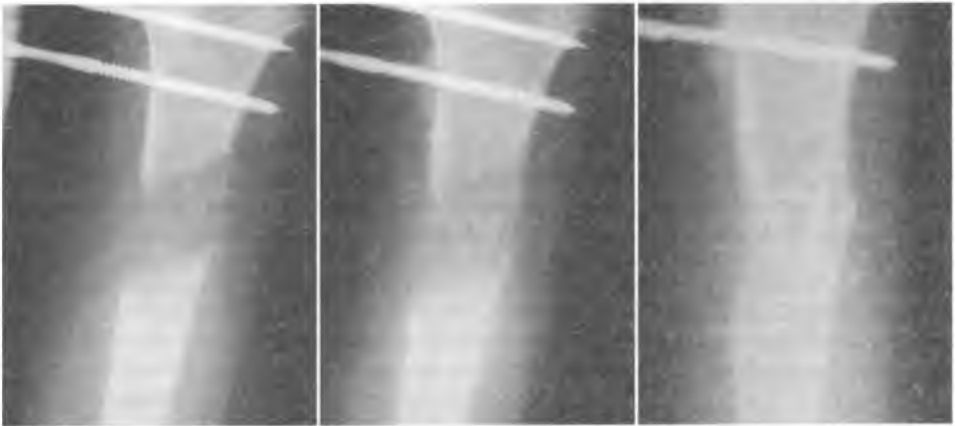


Fig. 4. Radiographs of the right femur of 17 years old boy. Before the first application of PRP (A), 4 weeks later after (B), and 10 weeks after application of PRP (C). Callus formation was satisfactory during the lengthening period

We examined seven patients (4 femoral and 3 tibial lengthenings) without PRP application at our institution using the Orthofix monolateral fixator and Ilizarov apparatus. These patients (controls) were compared to patients treated with PRP application for clinical assessment of the treatment. The average age at the surgery and the amount of lengthening were 15.7 years and 5.2 cm in controls, and 15 years and 4.75 cm in our series, respectively. The healing index of control patients ranged from 32.3 to 45.7 days/cm with an average of 38.2 days/cm. On the other hand, the average healing index of patients treated with PRP was 26.0 days/cm (23,2–30 days/cm).

Our study is comparable with Hiroshi Kitoh *et al.* (1) They have revealed an acceleration of new bone formation after PRP and marrow-derived mesenchymal stem cells transplantation in distraction osteogenesis. This is the only report on this topic available in on-line literature.

CONCLUSION

Intra regenerate PRP injection can be a factor causing shortening the treatment period by accelerating new bone formation during distraction osteogenesis.

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SUMMARY

The aim of the study was developing a method to enable acceleration of bone formation during limb lengthening using platelet-rich plasma (PRP). Two femoral and two tibial lengthenings were done in four patients because of a limb length discrepancy. PRP, which is known to contain several growth factors, was injected into callus at the consolidation period in each patient. The target lengths were obtained in every segment without major problems and the average elongation index was 26.0 days/cm (23,2–30,0 days/cm). After PRP instillation, following radiograms of all four patients represent significant acceleration of bone formation. Intra regenerate PRP injection can be a factor causing shortening the treatment period by accelerating new bone formation during distraction osteogenesis.

Miejscowe podanie koncentratu bogatopłytkowego u dzieci leczonych
metodą osteogenezy dystrykcyjnej – doniesienie wstępne

Celem badań było opracowanie metody umożliwiającej przyspieszenie przebudowy regeneratu kości podczas wydłużania kończyn z wykorzystaniem koncentratu bogatopłytkowego (PRP). Czterech pacjentów ze skróceniem uda (2 pacjentów), goleni (2 pacjentów) leczono z zastosowaniem osteogenezy dystrykcyjnej. Po zakończeniu wydłużania, w fazie konsolidacji, do regeneratu kostnego podano koncentrat bogatopłytkowy, będący źródłem autogennych czynników wzrostu. U wszystkich pacjentów uzyskano oczekiwane wydłużenie. Indeks wydłużania wyniósł średnio 26 dni/cm (23,2-30 dni/cm). Po podaniu PRP na kolejnych radiogramach widoczne było znaczne przyspieszenie przebudowy regeneratu. Podanie PRP do regeneratu u pacjentów leczonych metodą osteogenezy dystrykcyjnej wydaje się skutecznym sposobem na przyspieszenie przebudowy regeneratu.