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Operative Techniques in
Orthopaedics

Novel Applications of Platelet-Rich Plasma Technology in Musculoskeletal Medicine and Surgery

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Platelet-rich plasma (PRP) is an attractive novel option to promote healing and accelerate recovery after injury. We present a review of the current literature on PRP, highlighting the evidence for and against its use in orthopedic surgery. We recommend that PRP is used as part of prospective randomized studies so that its true efficacy can be determined in a scientific manner.
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Patients, physicians, and surgeons constantly search for new methods to promote healing and return to normal function after injury or for degenerative pathology. Accelerating the healing process reduces the socioeconomic effects of injury and illness, and, for professional athletes, it is important for their future career.

After acute trauma, tissue disruption results in bleeding and hematoma formation. There is subsequently an initial inflammatory response before the tissue becomes organized, heals, and matures. Conversely, microtrauma may occur without significant bleeding. This results in small tears, which, in some body sites, heal poorly and lead to the formation of painful weak degenerate tissue.

Platelet-rich plasma (PRP) presents an attractive option to improve and accelerate repair by concentrating the factors that enhance healing in normal healing tissues. The application of platelets with their accompanying growth factors (GF) improves the healing process initiated after an injury.[1] These encouraging clinical and laboratory results suggest that by applying PRP to the injured site, we advance over a phase of the natural healing process. When a tendon, or muscle, is injured, we expect it to go through the 3 known stages of the healing process: inflammation/degeneration, regeneration, and fibrosis. The platelets within the hematoma usually initiate the chemotactic cascade[2] and attract GF, which continue the process. PRP reduces the steps in the healing cascade and may be considered to yield better quality tissue over the same time.

PRP may be applied either by direct injection, for nonoperatively managed pathology, or intraoperatively. The latter can be undertaken either during arthroscopic surgery or by the physical application of a PRP liquid concentrate or matrix scaffold to repaired tissues.[3,4] Unlike steroid injections that predispose soft tissues to future injury, PRP does not have any described negative side effects. The fact that the treatment is being prepared from the subject's own blood makes it safe, without the risk of allergy or cross infection, relatively easy for a practiced clinician, and reproducible.

Most of the published evidence of the effectiveness of PRP, to date, is given by expert opinion,[5,6] and only recently, there are articles being presented on the role of PRP in musculoskeletal and orthopedic surgical applications.[7] These, however, are still considered novel and lack a proper evidence base. We will next discuss briefly the key articles, which form the scientific basis for the use of PRP. Our opinion is formed from the experience of 7 years and thousands of PRP applications in the management of sports injuries.

Decision Making

Following the basic first steps of appropriate clinical history, examination, and suggested diagnosis, imaging assists in establishing the exact location and extent of the injury. After an accurate diagnosis has been established, the different treatment options (conservative or operative) are considered. PRP forms an adjunctive therapy to all treatment methods. Regardless of the treatment option chosen, logistics, financial, and clinical aspects should be accurately outlined and presented in light of the experience of the treating center and

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current literature. To ensure that patient's (and family or coach) expectations are matched, patients must understand the pros and cons of the recommended treatment. One of the most crucial aspects, specifically with professional athletes, is the estimated time taken to return to daily activities and sport. For professional athletes, this is often more important than other aspects of treatment.

In general, PRP is applied either during conservative treatment or at surgery. As an adjuvant conservative measure, PRP may be applicable for most muscle tears, musculotendinous junction injuries, and tendon midsubstance tears—acute or acute on chronic—provided that the tendon ends are not retracted and there is no mechanical disturbance or interposition.[8] Until recently, PRP was mainly used to address pathologies, which had failed to respond to common treatment modalities and for which surgery was the next reasonable option, or when there was a need for a faster healing process to take place. Further research and the accumulation of beneficial results for PRP application in various pathologies have led to many more treatment indications; a few of these will be presented in the following paragraphs.

Applications During Surgery: General Concepts

PRP is being used during repair, reconstruction, or implantation procedures, whether open or arthroscopic. PRP can be applied intraoperatively or at the end of an open surgical procedure. Alternatively, injections may be administered after the initial surgical hematoma has resolved or arthroscopic irrigation fluid has absorbed as an adjunct to surgery. In this case, additional injections should be timed at 3-5 days after surgery to maximize the initial healing process.

There have been several articles published on human subjects, reporting on the outcome after surgery with the addition of PRP. Procedures reported include treatment for subacromial bursitis and impingement,[9,10] open decompression and rotator cuff (RC) surgery,[11-15] spinal fusion,[16,17] total knee arthroplasty,[18,19] and anterior cruciate ligament (ACL) reconstruction.[20-23]

When PRP is administered at arthroscopy, the injection should be performed after draining the joint or the subacromial space of irrigation fluid. Precise intra-articular application can be performed for meniscal repair and glenoid labrum restabilization by leaving the needle at the tear site just before performing the repair.

In open or mini-open surgery, PRP can be applied as a gel just before closure or by infiltrating the concentrate over the desired area. PRP gel matrices can also be sutured or glued to the surgical site, for example, over a RC repair. The application of a PRP mesh has the benefit of ease of use, but the timing of application is critical to optimize the benefit from the GF. As the matrix forms by coagulation, many of the GF are used during this stage. The preparation of 2 serum samples with staged activation allows the first to be used to from the matrix; the second sample that is activated is used to "recharge" the matrix with new factors before application.

Novel and Surgical Application of PRP

Achilles Tendon, Partial Tears, Complete Tears, and Postrepair

At a microscopic level, injections of PRGF (plasma rich in GF, a form of PRP) within Achilles tendon fascicles in sheep lead to increased cell number and florid angiogenesis.[24-26] Tenocyte stem cells became larger, were well spread, and elongated with the down regulation of the expression of nucleostemin after PRP application.[27] Lyras et al[28,29] reported faster healing of the PRP group compared with controls and histologically increased numbers of various cell types during the first 2 weeks and varying responses of interferon growth factor (IGF)-1 and transforming growth factor (TGF)-beta GF during the first 4 weeks.

In addition to biochemical and histologic changes, improved biomechanical properties have been noted after the use of PRP. The tendon callus strength and stiffness of transected Achilles tendons of rats was 30% higher at 1 week with PRP treatment.[30,31]

Although there are relatively few studies in human patients, patients with ruptured Achilles tendons have shown accelerated functional recovery with the addition of PRGF injections.[32] Patients who received PRGF also exhibited decreased cross-sectional area in the healed tendon after 18 months.

Schepull et al[33] performed a randomized study applying PRP to the treatment group during Achilles tendon repairs. Before skin suture, patients were injected with 10 mL of PRP (10 times higher platelet concentration than peripheral blood). The primary effect variables were elasticity modulus at 7 weeks and heel raise index at 1 year. The results suggest that PRP is not useful for treatment of Achilles tendon ruptures.

A 10 times higher platelet concentration than peripheral blood would actually inhibit platelet function rather than stimulate GF work. Moreover, the application of PRP during the surgery in the acute phase, when bleeding and swollen tissue are still present, might decrease the efficacy of the PRGF.

After noting that 3 professional basketball players who had percutaneous Achilles tendon repairs injected with PRGF returned to play within 4 months of surgery, we performed a level 1 study comparing repair augmented with ultrasound (US)-guided PRGF injections. We noted improved healing characteristics at early stages but with reduced scar formation and more normal looking tissue in the treatment group (Fig. 1). In our study, PRP/PRGF (2.5-3 times higher platelet concentration than peripheral blood) was applied 7 days postsurgery. At this point, the acute phase response to injury and surgery had been completed.

In our experience, in professional athletes, partial tears of the Achilles tendon and tears at its musculotendon junction can be successfully treated with PRGF. This treatment method would be followed by a shortened rehabilitation pro-

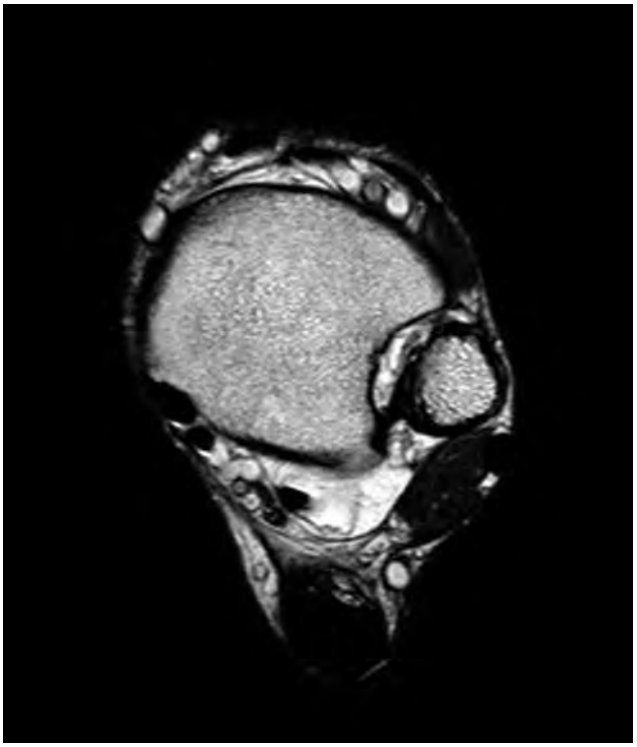

Figure 1 MRI scan of the Achilles after repair with supplementation by the administration of platelet-rich plasma (PRP) (Courtesy of Omer Mei-Dan, MD).

tocol than the one applied after a surgery or conservative treatment, with good long-term outcome.

Syndesmosis Sprains

We have conducted a randomized control trial evaluating outcome and the return-to-play (RTP) time for professional athletes suffering from high ankle sprains treated with PRGF injections. Both groups were diagnosed with magnetic resonance imaging (MRI) and dynamic US examination within 10 days of injury, confirming a tear of the anterior inferior tibiofibular ligament. This cohort had the requirement and infrastructure to resume activity as soon as possible. The treatment consisted of an US-guided injection of 3 mL of PRGF. Postinjection rehabilitation protocol was identical, involving use of a short leg cast or walking boot with a heel raise, nonweight bearing, for 10 days. Group 1 was injected again after 7 days, and the boot was reapplied. Full weight bearing in the boot was permitted 10-14 days after treatment initiation. For group 1, this was after the first injection, and for controls, this was after diagnosis and application of the cast. Dynamic US examination was performed after 3 weeks, 6 weeks, and 5-6 months postinjury. Clinical examination was performed at cast removal and before resumption of full training, when a single leg hop and star test was completed.[34] RTP time was significantly shorter in the treatment group (41 vs 64 days), whereas pain on full activity resumption was reported only in the control group. Dynamic US examination revealed a shorter time for the syndesmosis to stabilize, defined as the absence of pathological widening under external rotation stress. Laxity measurements were better in the long term (6-12 months follow-up) for those treated with PRGF. In chronic or misdiagnosed cases, when the syndesmosis injury requires reconstruction, we have used PRP as an adjuvant treatment (Fig. 2A, B).

Osteochondral Lesions and Cartilage Degeneration

Given the relative ease of treatment and potential benefit, it is surprising that to date, there has been little published on the effect of PRP on the management of notoriously difficult-to-treat articular cartilage degenerative conditions, chondral defects, and osteochondritis dessicans.

Kon et al[35] studied 100 consecutive patients with chronic cartilage degeneration of the knee, treated with intra-articular injections of PRP. Preliminary results indicate that the treatment with PRP injections is safe and has the potential to reduce pain and improve knee function and quality of life in younger patients with minor degeneration. Statistically significant improvements were observed in all the variables evaluated. However, the beneficial effects of pain reduction and improved function were reduced at the 12 and 24 months follow-up, with a median duration of the beneficial effect of 9 months.

Osteochondral lesions (OCL) occur most frequently in the knee, elbow, and ankle. They are most commonly found in

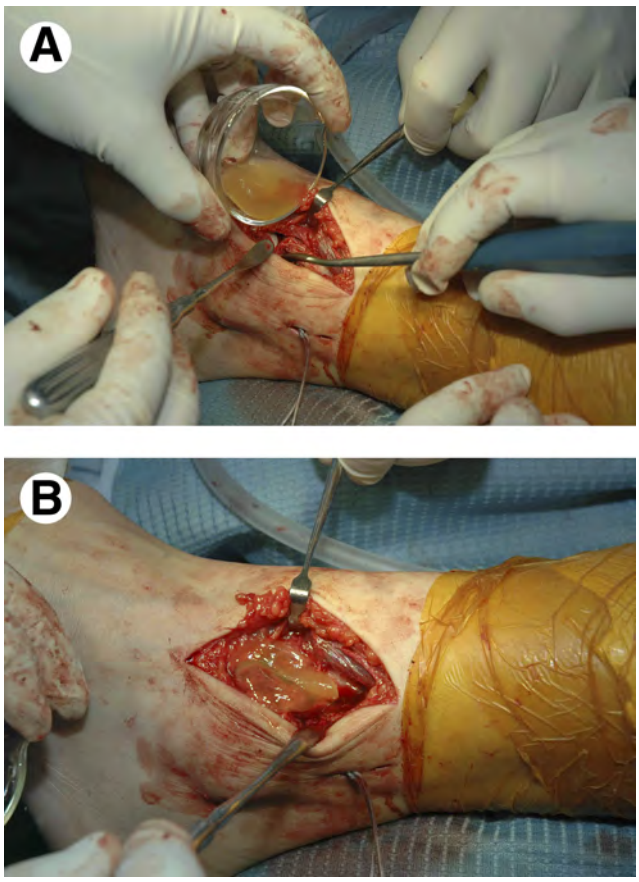

Figure 2 (A, B) The placement of PRP gel matrix on a reconstructed ankle syndesmosis (Courtesy of Omer Mei-Dan, MD).

young active males. The causes include trauma, ischemia, abnormal ossification, or genetic predisposition.[36,37] Lesions may heal spontaneously or progress to chronic symptoms of deep joint pain, worse on weight bearing and exercise.[38] Chronic lesions have subchondral cystic change and may detach, forming loose bodies leading to catching, stiffness, and swelling of the joint.[37,38] Because articular cartilage is aneural, the pain is thought to arise from the subchondral bone beneath the OCL defect, possibly due to the increased fluid pressure during weightbearing.[37]

A variety of treatments exists for OCL of the talus, with management options based on the stage of the lesion. The conservative treatment options are limited,[38] tend to be reserved for edematous or nondisplaced lesions, and include immobilization, restriction of weight bearing, and physiotherapy. Surgical intervention is recommended if nonoperative treatment is unsuccessful or for initial treatment of partially or completely detached lesions.[39,40]

We have performed a randomized controlled study to evaluate the short-term efficacy and safety of PRP compared with hyaluronic acid (HA) in reducing pain and disability caused by OCL of the ankle.[41] Thirty osteochondral lesions, 15 per arm, received 3 consecutive intra-articular therapeutic injections of PRP or HA. Patients were followed up for 4, 12, and 30 weeks after treatment, and they showed a statistically significant improvement for the PRP treatment compared with HA for ankle hind-foot score, Visual Analogue Scale (VAS) pain, stiffness, and function and subjective global function. The outcomes reported in our study would suggest that nonoperative treatment with PRGF, in our hands, is comparable in efficacy, in the short term, with results after surgical intervention,[39] and it should be considered as a valid first-line treatment. OCL of the ankle treated with intra-articular injections of PRP resulted in a decrease in pain scores and increase in function for >6 months.

Tear of the Medial Collateral Ligament of the Elbow

We recently published a case report of an Olympic judoka who had completely ruptured his elbow medial complex (both medial collateral ligament and common flexor tendon origin), just 10 months before the Olympic Games (Fig. 3A). Surgery at that stage would have ruled out participation in any competition within the next 6-8 months, and particularly qualification competitions. He decided on a conservative management plan involving PRGF injections together with an accelerated rehabilitation protocol. He received 2 injections during recovery, at 1 and 2 weeks after injury, and by 6 weeks, his elbow had stabilized. He went on to win a gold medal in a world cup tournament, 5 and a half months after his injury (Fig. 3B).[42]

This case encouraged us to use PRGF in the management of tear of the lateral ligamentous complex of the ankle and medial collateral ligament injuries of the knee. Observation of the healing times of our cohort would suggest earlier RTP and alleviation of long-term–associated pain.

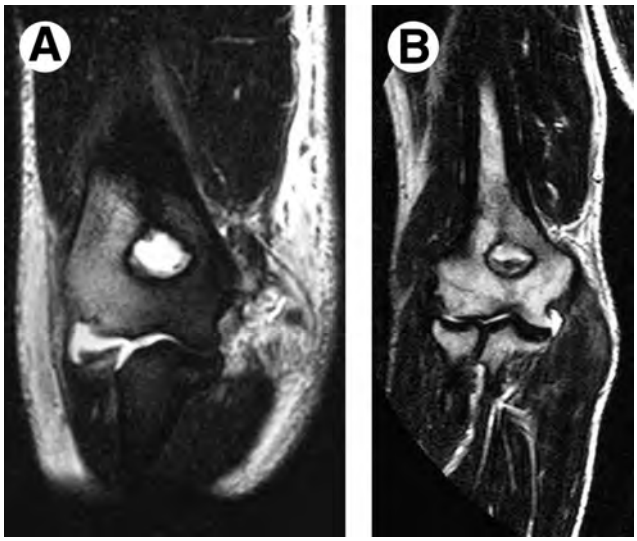

Figure 3 MRI scans of a medial collateral elbow injury after injury (A) and at 6 weeks after injury (B) (Courtesy of Omer Mei-Dan MD).

Tenosynovitis and Tendon Microtears

We have used PRGF successfully for the management of tendon problems for degenerative pathology of both tibialis posterior and peroneal tendon sheaths.

A 34-year-old international professional volleyball player reported ongoing right medial ankle pain. She was able to train and play, but, being a spiker, she found it painful to jump and land. Examination revealed point tenderness behind the medial malleolus, and resisted inversion and single heel raises reproduced the symptoms. MRI and US images of tenosynovitis and microtears of the tibialis posterior tendon are shown in Figure 4A. Three consecutive fortnightly US-guided PRGF injections were performed after aspiration of the tendon sheath (Fig. 4B). After each injection, the player was rested for 4 days, barring physical therapy. Active training was resumed at 5 days after each injection. The symptoms completely abated, and she was able to train 20-25 hours per week and continued to play at the elite level.

Anterior Cruciate Ligament Reconstruction Surgery

PRP has been used in the field of ACL reconstruction surgery to assist graft integration and donor site healing. Some preliminary studies report on the use of PRP to augment ACL reconstruction. PRP was used with hamstring double-bundle ACL reconstruction aiming to accelerate tendon-to-bone integration in the femoral tunnels, and, therefore, allow an earlier and safer return to sport. MRI performed 3 months after surgery did not show any increased graft integration.[21] Other investigations using PRP on ACL reconstructions have demonstrated theoretical benefits on the use of PRP. One study showed no significant effects of the platelet concentrate on the osteoligamentous interface or tunnel widening evolution. However, graft maturation was thought to be enhanced according to MRI signal intensity.[20] Similarly, a homogenous

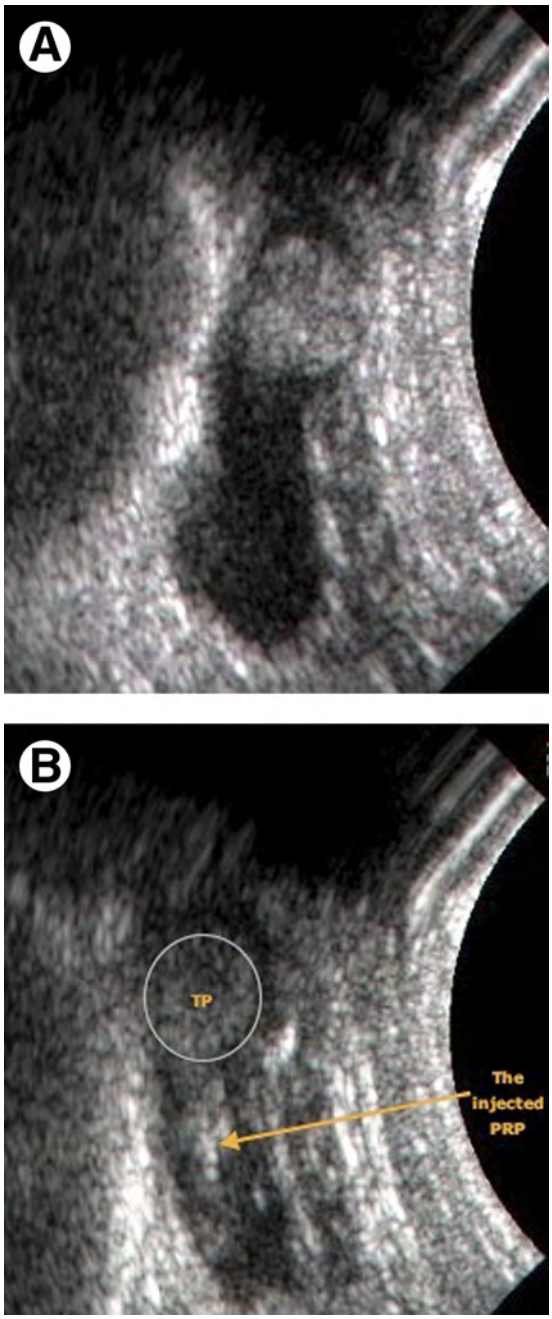

Figure 4 Ultrasound of the tibialis posterior tendon sheath before (A) and after (B) (Courtesy of Omer Mei-Dan, MD).

graft signal was noted in half the time in patients in whom PRP had been used after surgery.[22]

Cervellin et al[23] performed a clinical randomized controlled study where PRP gel was applied to the bone patellar tendon bone autograft site to reduce anterior knee pain and pain on kneeling. PRP gel was applied to the patella and tibial tubercle sites, and the overlying paratenon was repaired. At 12 months after surgery, Victorian Institute of Sports Assessment (VISA) scores were significantly higher in those treated with PRP, but no significant difference in postoperative VAS pain scores was observed. On MRI imaging, in 85% of the patients in the PRP group, the tibial and patellar bone defect was satisfactorily filled by new bony tissue (>70% of bone gap filled) compared with 60% of controls, although this was not statistically significant. PRP was therefore considered useful in reducing subjective pain at the bone-patellar tendon-bone (BPTB) donor site.

Repair of the Rotator Cuff

The theoretical advantages of the use of PRP would make it ideal for use with tears of the RC, those being typically degenerative in nature.

PRP was used to augment arthroscopic cuff repair in a case series of 14 patients, leading to improved pain alleviation and functional outcome without any adverse events.[11] This series was followed by a prospective RCT in which patients reported significantly less pain and improved strength in external rotation and functional Simple Shoulder Test, UCLA, and Constant scores at 3 months after surgery. No difference was shown in scores between the 2 groups at 6, 12, and 24 months or on imaging. For smaller tears (grade 1 and 2) with less retraction, there was significantly higher external strength at all stages in those patients who had received PRP treatment.[12]

Castricini et al[14] used of an autologous platelet-rich fibrin matrix for the treatment of RC tears. There was no significant difference in Constant scores in small and medium-sized tears at 16 months postsurgery. Most PRP series suggest early or short-term early benefit, which, in most cases, even up in the long term.

Recently, Barber et al[15] assessed the effect of PRP on postoperative RC tendon healing as determined by MRI and clinical outcome at 31 months after arthroscopic RC repair. A single-row cuff repair to the normal footprint without tension or marrow vents was performed, augmented by PRP. Postoperative MRI studies showed persistent full-thickness tendon defects in 60% of controls but showed only 30% of PRP-augmented repairs ($P = 0.03$). In the control group, of the tears measuring <3 cm in anteroposterior length, 50% (7 of 14) healed fully, whereas 86% of the PRP group healed fully ($P < 0.05$). Other than the Rowe scores, there was no postoperative clinical difference. The addition of PRP construct sutured into a primary RC tendon repair, resulted in lower retear rates identified on MRI than control repairs.

Spinal Fusion

The results of PRP in spinal fusion applications are limited and controversial, with beneficial and inhibitory effects being reported.[16]

Hartmann et al[17] studied the effects of PRP on patients undergoing an anterior spinal fusion. Fifteen patients, who had suffered an injury of the thoracic or lumbar spine and had undergone an anterior fusion using cages, received additional posterior stabilization and/or anterior implants with bone graft combined with PRP versus control. The grafted area was assessed for fusion by analysing CT scan results. The outcome showed no significant differences between the 2 groups. The additional application of autologous PRP involves little risk for the patients, and the results showed that

the use of PRP provides a faster fusion and higher density values within the fusion mass.

Sys et al[16] conducted an RCT assessing both the clinical and imaging effects of PRP being added to autograft iliac crest bone during lumbar interbody fusion. PRP leads to an improvement of the VAS score and a more pronounced physical component summary score. CT scans showed uneventful bony healing in all but 1 patient, with no difference between groups. From a clinical and radiographic point of view, the use of PRP seems to be justified in posterior lumbar interbody fusion surgery; however, economically, the expense of PRP cannot be justified until statistical significance can be reached in a larger study.

Preparation and Application Techniques

The term PRP may be applied to any fraction of autologous blood that has a higher concentration of platelets than baseline.[43,44] Centrifugation allows the separation of blood into its component cells and serum. The different preparation techniques, quantities, speeds, and so on lead to variation of the volume and concentration of serum, platelets, and GF yielded. Typically, 10% of the initial volume of autologous blood is yielded as PRP concentrate after centrifugation.

A therapeutic dose of PRP would need to have 3-6 times greater concentration of platelets than at baseline.[45,46] Higher concentrations have an inhibitory effect.[47] In an animal model, a decrease in platelet concentration from 5 times to 3 times to the PRP enhanced suture repair of the ACL, but did not significantly alter the outcomes of mechanical testing.[48]

Depending on the preparation system used, white cells may or may not be removed from the sample. Neutrophils are now considered to lead to additional muscle damage after the original injury, and there is no evidence that they play a beneficial role in muscle repair or regeneration.[49]

The process of PRP preparation is relatively straightforward, and once mastered, it can be completed in a few minutes in the clinic or in the operating room. The cost varies widely depending on the method used to produce the PRP. All methods require a small sample of the patient's blood, which is separated into its constituent cells and plasma using a centrifuge. The food consumed and the state of hydration of the patient before venisection also influence the sample of PRP produced. For consistency, patients are asked to fast for 3-4 hours before the blood samples are taken.

Most of the commercially available PRP kits use a patent-registered syringe to collect, spin, and apply the sample for easy concentrate application and eliminate the need for manual separation. These kits will always produce PRP-containing leukocytes, as gravity separation of fractions after centrifugation cannot differentiate between the leukocytes and the lowest plasma layer known to be rich with GF. Cheaper financially, but manually time-demanding methods, involve the physical manual aspiration of high-grade PRP (Pure-PRP). This separation process may be performed in a laminar flow preparation cabinet or in the operating theater, that is, sterile environment, to minimize the risk of infection.

In addition to the variations in quality and composition of PRP, there are variations in the methods of administration. These methods include the form of application, the availability of the PRP as liquid or a gel matrix, the timing of treatment and injections, and the number of injections per series or volume of injection.

Around the Injection

The volume and timing of the application vary according to the concentration and activation of the platelet components. After production, the serum in the sample starts to coagulate. The platelets start secreting GF immediately, and after 10 minutes, the rate of production decreases, with the majority of presynthesized GF secreted within the first hour.[43,44] Sodium citrate is added to the serum sample to delay clotting preapplication, and then, calcium chloride is used to reactivate the sample. The administered platelets will synthesize and secrete additional GF for 7-10 days. This initial burst is short lived but has prolonged efficacy.[44,50]

As PRP is considered to act best when placed at the site of injured tissue, we recommend US guidance to verify accurate needle placement. It may be assumed that application bathing the concentrate around and over the injured tendon would be sufficient for absorption into the healing area, preventing separation of healing layers of tendon fibrils. We consider it beneficial to aspirate exudates, hematoma, or reactive inflammation around the tendon before PRP is injected. Ultrasonography is a useful tool for clinical evaluation and interventional applications. It is widely advocated in joint and soft-tissue aspiration and injections in clinical practice (Fig. 5). This optimizes injectate placement when optimal accuracy is necessary for both diagnostic and therapeutic purposes, and it can assist in avoiding iatrogenic injury or irritation to adjacent tissues and structures during the procedure. Moreover, the procedure is performed without exposing the patient and physician to the risks of radiation.

For safety reasons, we recommend the use of a Luer lock

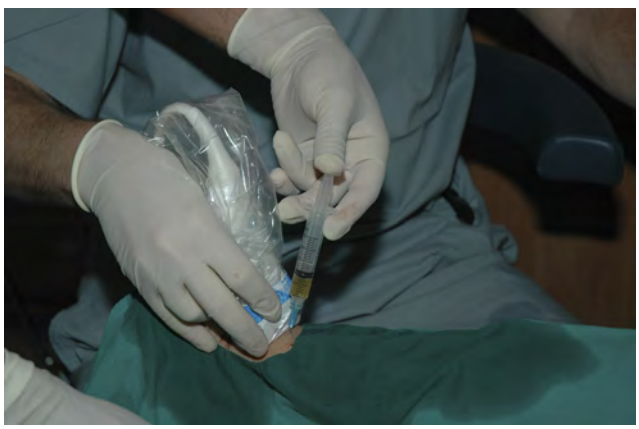

Figure 5 Ultrasound-guided PRP injection into the Achilles tendon after repair (Courtesy of Omer Mei-Dan, MD).

syringe. This prevents separation of the needle from the syringe during injection. Detachment is dangerous, as it can cause the hazardous spraying of biological material, with inoculation risks and the loss of the precious PRP. Gentle slow injections also prevent needle misplacement.

Concern has also been raised about the concomitant use of local anesthetics with PRP injections. This is thought to be due to pH tissue changes and the biological activity of the PRP concentrate and the surrounding environment. We therefore recommend avoiding local anesthetic when injecting PRP into a relatively superficial tissue. Local anesthetic can be used in the subcutaneous tissues only when injecting deep structures.

Postoperative Management/Rehabilitation

Given the laboratory evidence of quicker and stronger healing with the use of PRP,[30,31] it seems reasonable to commence postoperative mobilization earlier, after the initial swelling and bruising has settled.

Given a program of criterion-based progression consisting initially the quality of the repaired tissue, the degree of pain, range of motion (ROM), end feel, quality of ROM neuromuscular control, proprioception and strength, it is likely that patients will recover rapidly.

Care should be taken with the provision of postoperative analgesia. The majority of patients use a combination of analgesics and anti-inflammatory medication. It seems illogical to introduce GF from platelets to promote healing and concurrently administer anti-inflammatory medications with a mechanism of action based on inhibition of platelet function. Although there are published data on the role of non-steroidal anti-inflammatory drugs (NSAIDs) and the healing of various tissues, such as bone, tendon, and muscle, there are no data from which we can draw guidance on their concomitant use with PRP. We therefore recommend the avoidance of use of NSAIDs, when possible, at least 2 days before PRP application and throughout the treatment time frame, usually up to 2 weeks after application.

In Achilles tendon repair, those patients who had received PRP recovered normal range of mobility after 7 weeks rather than 11 weeks, and they were able to RTP earlier at 14 weeks, compared with 22 weeks for the control group, without any increase in rerupture rate.[32] Similarly, after total knee arthroplasty, patients showed improved ROM by the sixth week postsurgery.[18,19]

Given the reported improved outcomes with the addition of PRP, many clinicians using PRP in their practice would speed up the standard rehabilitation processes. There are clearly advantages to professional athletes wishing to RTP in as short a time as possible. Most of the published literature of accelerated RTP with professional athletes is anecdotal, and prospective studies are only currently at the design and initial phase. One of the major problems is the adoption of differing rehabilitation protocols for the treatment and control arms of the study. Also, it would be unethical to speed up the control group rehabilitation regimen, placing them at increased risk of reinjury.

Given the lack of definite current evidence for the benefits of GF to promote healing and strengthening of the tissue formed, some sports' physicians believe that rehabilitation regimes should remain unaltered.[51]

So far, PRP has been administered mainly during the inflammatory and proliferative stages of healing, typically during the first 6 weeks after surgery. It is logical to assume that PRP injections further down the healing pathway will have an additional beneficial effect on the recovery process. We are currently studying this hypothesis using a level 1 study design.

Conclusions

The use of PRP improves healing when compared with standard healing times, but there is currently a lack of prospective randomized studies in this field. It is logical to assume that PRP injections after surgery will have a beneficial effect on the ongoing healing process. To date, there have been no complications reported from its use. As research progresses, the benefits of PRP and PRGF injections are being increasingly appreciated, particularly in terms of short-term functional outcome. The current lack of evidence is not a reason to withhold its use, and PRP can be considered as an adjunct to all aspects of orthopedic surgery but should still be considered experimental. We encourage randomized prospective studies using a standardized form of PRP so that efficacy can be determined and firm conclusions can be made.

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