Platelet-Rich Plasma (PRP): The Radiologist's Role in Diagnosis and Treatment

Kenneth S. Lee, MD, John J. Wilson, MD,MS, Colin Strickland, MD

DEPARTMENT OF Radiology
UNIVERSITY OF WISCONSIN
SCHOOL OF MEDICINE AND PUBLIC HEALTH

Objectives

1. Introduce the emerging use of PRP in sports medicine and radiology clinics.
2. Discuss the clinical applications of PRP in treating sports-related injuries.
3. Show how ultrasound-guided PRP treatment is performed from preparation to injection to post-procedure care.
4. Explore the role of imaging in future PRP research trials.

Background for Emerging Use of PRP

- Chronic musculoskeletal tendon injuries have long eluded the use of standardized therapeutic protocols.
- Ultrasound-guided fenestration or tenotomy has been used with some success as a potential treatment for chronic tendinopathies.
- A wide array of injectable agents, such as hyperosmolar dextrose (Prolotherapy) to complex orthobiologic agents such as bone morphogenic protein have also been extensively used, but none have had uniform success.
- Platelet-rich plasma (PRP) injection has emerged as a treatment alternative for many musculoskeletal conditions, both acute and chronic.

Courtesy of Jeff Miller
University of Wisconsin-Madison

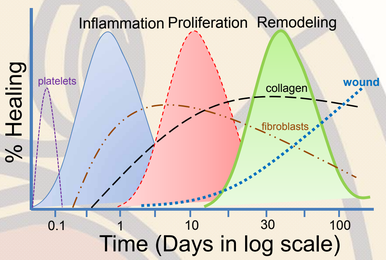
- PRP has been popularized by the media after its successful effects in high level professional athletes.

Fact:

- There are an estimated 100 million sports-related injuries every year in the United States.

What is PRP?

- Platelet-rich plasma is defined as a platelet concentration higher than the physiologic platelet concentration found in healthy whole blood.
  - ➢Average normal platelet count = 200,000 per µl
  - ➢Normal range = 150,000 to 350,000 per µl
  - ➢PRP count = 1,000,000 per µl (5X concentration)
- The first step of the healing process is clot formation and platelet activation.
- After platelet activation, wound healing involves an intricate process that is often categorized into three overlapping phases: **inflammation, proliferation,** and **remodeling**.



Inflammatory phase: release of growth, bioactive, and hemostatic growth factors.

Proliferative phase: consists of angiogenesis, collagen deposition, granulation tissue formation, epithelialization, and wound contraction.

Remodeling phase: involves collagen maturation and apoptosis of excess cells.

- The potential benefits of PRP are thought to rely on the intrinsic properties and interplay between the concentrated growth factors at the cellular level , such as TGF-β, PDGF, and VEGF.

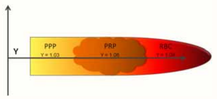
Fact:

- Platelets are small anucleated cytoplasmic fragments of megakaryocytes responsible for hemostasis, but critical for wound tissue healing.

How is PRP prepared?

- PRP is commonly prepared in the outpatient sports medicine clinic or radiology setting using a table-top centrifuge machine.

- Centrifuge systems differ in ability to separate RBCs from platelets affecting concentration and composition, which is a major reason for lack of standardization.
- The working definition of PRP is 1,000,000 per µl platelet count, which is five times the normal concentration found in whole blood.
- Centrifugation separates the whole blood into three layers: red blood cells (bottom layer, specific gravity =1.09), platelet poor plasma (top layer, specific gravity = 1.03), and platelet concentrate that contains white blood cells (middle layer, specific gravity = 1.06).



- PRP preparation begins with venipuncture and collecting 30 ml of autologous whole blood into a syringe containing an anticoagulant, then centrifuged for about 15 min. to yield 3 ml of PRP (arrow).

- Typically 3 ml of PRP is injected directly into the diseased tendon using ultrasound-guidance.

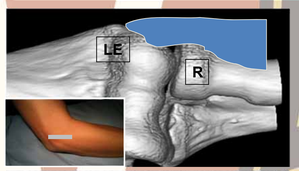
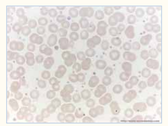


Figure 1

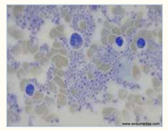
3D Computed Tomoography image illustrating the anatomy of the common extensor tendon origin (blue). Inset shows elbow position and transducer placement in long axis. Radial head (R), lateral epicondyle (LE).

Figure 2

Ultrasound (US) of common extensor tendon during needle placement in a 45-year-old male with lateral elbow pain. US evaluation before and during PRP treatment enables precise needle placement into abnormal areas of the tendon, which include hypoechogenicity (arrow) or hyperemia (not shown). 22-gauge, 1.5 inch needle (arrowheads) is shown within the substance of the common extensor tendon. Osteophyte (pentagon) commonly seen in setting of tennis elbow. Radial head (R), lateral epicondyle (LE).



Whole Blood Smear



PRP Smear

Clinical uses of PRP

- PRP therapy is permeating radiology practices collaborating with sports medicine clinics, utilizing ultrasound for both diagnosis, guidance for precise needle placement, and follow-up.
- The clinical applications of PRP are growing and include treatment of chronic tendinopathies, such as lateral epicondylosis ('tennis elbow'), Achilles tendinopathy, medial collateral ligament injuries, and plantar fasciopathy.
- Chronic tendinopathy results from a cycle of disrepair, often treated symptomatically with steroid injections that weaken tendon and inhibit healing (Diagram illustrates process).

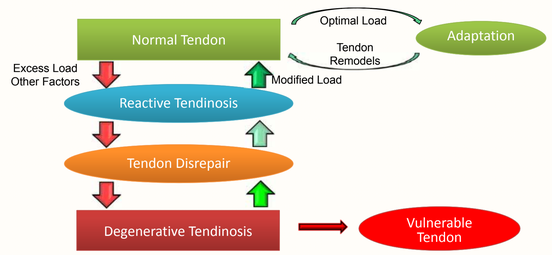
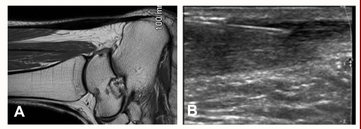


Figure 3

Ultrasound-guided needle placement in the Achilles of a 46-year-old female with chronic refractory pain. A, Sagittal proton density-weighted MRI rotated counterclockwise 90 degrees shows midsubstance Achilles thickening (arrows). B, Long axis US image in same orientation shows intratendon (arrows) needle placement (arrowhead) during PRP injection.



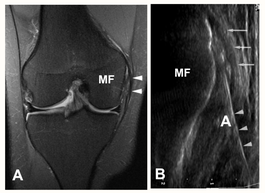


Figure 4

Ultrasound-guided needle placement in medial collateral ligament (MCL) injury in a 20-year-old female soccer player. A, Coronal proton density-weighted fat saturation MR image shows thickening of the proximal MCL from a sprain injury. B, Corresponding ultrasound image (rotated 90 degrees clockwise) showing 22-gauge needle placement (arrowheads) into the proximal portion of the MCL (arrows). Medial femoral condyle (MF).

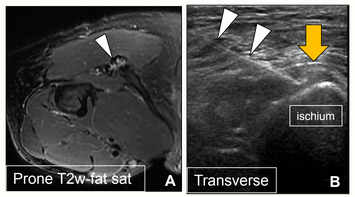


Figure 5

US-guided PRP injection of the left hamstring origin in a 47-year-old woman triathlete. **A**, Axial T2-weighted fat sat MRI (rotated 180°) corresponding to prone position during injection shows high signal and thickening of the hamstring origin (arrowhead). **B**, Corresponding transverse US image showing needle placement (arrowheads) into hamstring origin (arrow).

Post-Procedure Protocol

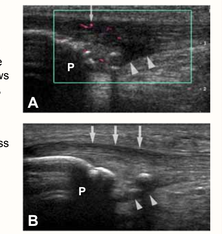
- Patient is educated on both short-term and long-term expectations.
- PRP injection promotes local inflammation, so pain should be expected, which can be treated with ice and narcotic prescription such as vicodin.
- Anti-inflammatory drugs (NSAIDs) should be avoided for at least two weeks.
- Immobilization for 48 hours and then protected weight bearing for 2 weeks in cases such as plantar fasciopathy or Achilles tendinopathy.
- Physical therapy at least two weeks after the procedure.
- Gradual return to activity over 6 to 8 weeks.

PRP Research

- Clinical studies have reported that PRP use can shorten recovery time, enhance tendon strength, and decrease wound infection. However, evidence is limited.
- Recent double-blinded randomized control trial (N=100) for tennis elbow comparing PRP to corticosteroid injections found a significant difference in disease specific quality of life in pain scores favoring the PRP group:
  73% PRP vs. 49% Steroid (p<.001)
- Another recent double-blinded randomized control trial (N=27) for Achilles tendinopathy found no difference between the PRP and sham saline injections groups. However, study was limited by sample size and confounded by eccentric exercise used in both groups.
- PRP is a promising treatment but more studies are needed, which should include imaging as an outcome measure.

Figure 6

Healing patellar tendinopathy after platelet-rich plasma treatment in a 23-year-old male athlete. A, Ultrasound long axis image shows thickening, hypoechogenicity (arrowheads), and hyperemia (arrow) of the proximal patellar tendon. B, Ultrasound long axis image in same patient 6 months after PRP treatment showing decreased thickness, less hypoechogenicity (arrowheads), and normalization of the parallel collagen fibers (arrows) of the proximal patellar tendon. Inferior patella (P).



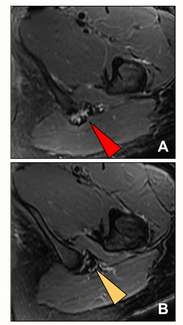


Figure 7

MRI evidence of healing hamstring origin six months after PRP treatment in same 47-year-old woman triathlete shown in Fig 5. **A**, Axial T2-weighted fat sat MRI shows increased signal and thickening of the right hamstring origin (arrowhead). **B**, Corresponding axial T2-weighted fat sat MRI six months after PRP treatment and symptom improvement showed decreased signal abnormality and thickening of the hamstring origin (arrowhead).

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