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CASE REPORT

Platelet-rich Plasma Injection for the Treatment of Partial Achilles Tendon Rupture: A Case Report

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ABSTRACT

Introduction: Achilles tendon rupture is one of the most common adult tendon injuries and continues to increase in incidence. This case report outlines a comprehensive approach for stand-alone leukocyte-poor platelet-rich plasma treatment of a partial subacute Achilles tendon rupture in a professional athlete who had received prior autologous conditioned serum injections with an interleukin-1 receptor antagonist.

Patient History: A 32-year-old male professional ice hockey player presented with persistent left ankle pain approximately seven months after suffering a partial acute Achilles tendon tear. Imaging confirmed a subacute partial Achilles tendon rupture.

Injection: Following local anesthesia, a 25-gauge 1.5-inch needle was advanced to the target structure under ultrasound guidance and 3 mL of autologous platelet-rich plasma was divided amongst several areas of the patient's Achilles tendon, while simultaneously tenotomizing the tendon. No complications were observed.

Imaging: Follow-up magnetic resonance imaging approximately 9 months after platelet-rich plasma injection revealed complete resolution of the Achilles tendon rupture.

Conclusion: Ultrasound-guided leukocyte-poor platelet-rich plasma injection could be considered an effective treatment option for acute Achilles tendon rupture during the subacute stages of tendon healing, leading to complete radiographic resolution of the tear and enabling a return to high-level athletics.

Introduction

The Achilles tendon is the largest and strongest tendon in the body[1] and can reportedly endure forces as high as 9 kilonewtons, corresponding to 12.5 times an individual's body weight.[2] Acute Achilles tendon rupture is one of the most common adult tendon injuries and continues to increase in incidence.[3–6] An average of 75% of Achilles tendon ruptures occur while playing sports—often recreational athletes, with the mechanism involving sudden acceleration or jumping movements in an otherwise sedentary patient population.[7] Particularly competitive athlete populations are at an increased lifetime risk for Achilles tendon rupture: sprinters (18%), decathletes (17%), soccer players (17%), track and field jumpers (12%), basketball players (12%), and ice hockey players (9%).[8] The mechanism of acute Achilles tendon rupture is incompletely understood but commonly occurs when athletes suddenly intensify their training.[7]

Previously, treatment approaches for acute Achilles tendon rupture were divided into surgical repair, utilizing either percutaneous or open techniques, and conservative options.[9] Conservative methods involved a gradual, supervised progression of ankle dorsiflexion with the assistance of heel lifts.[10] Surgical repair was effective in reducing re-rupture rates but carried a higher risk of complications, including sural nerve injury, tendon adhesions, and superficial infection. The literature demonstrates that conservative management yielded comparable outcomes in terms of function and re-rupture rates.[11]

An emerging third option for acute Achilles tendon rupture has been the use of platelet-rich plasma (PRP) to augment previous treatment methods or as a stand-alone strategy.[12–14] However, PRP treatment remains controversial, with a lack of consensus on its efficacy.[12] The non-standard nature of PRP preparation, injection technique, and follow-up imaging present further obstacles to studying its effectiveness.

A paucity of literature addresses the approach to a patient presenting after prior treatment for an acute Achilles tendon rupture and the potential benefits of additional PRP injections. PRP literature often lacks reporting of platelet dosing, which promotes further uncertainty as to its efficacy as a treatment option. This case report outlines a comprehensive approach for stand-alone PRP treatment of a partial subacute Achilles tendon rupture in a professional athlete who had received prior autologous conditioned serum injections with an interleukin-1 receptor antagonist (IL-1Ra) known as Orthokine (Orthogen, Düsseldorf, Germany; known as Regenokine in the United States). This report includes an analysis of the accompanying hematologic injectate composition as well as initial and follow-up magnetic resonance imaging (MRI) confirmation of Achilles tendon healing.

Case Presentation

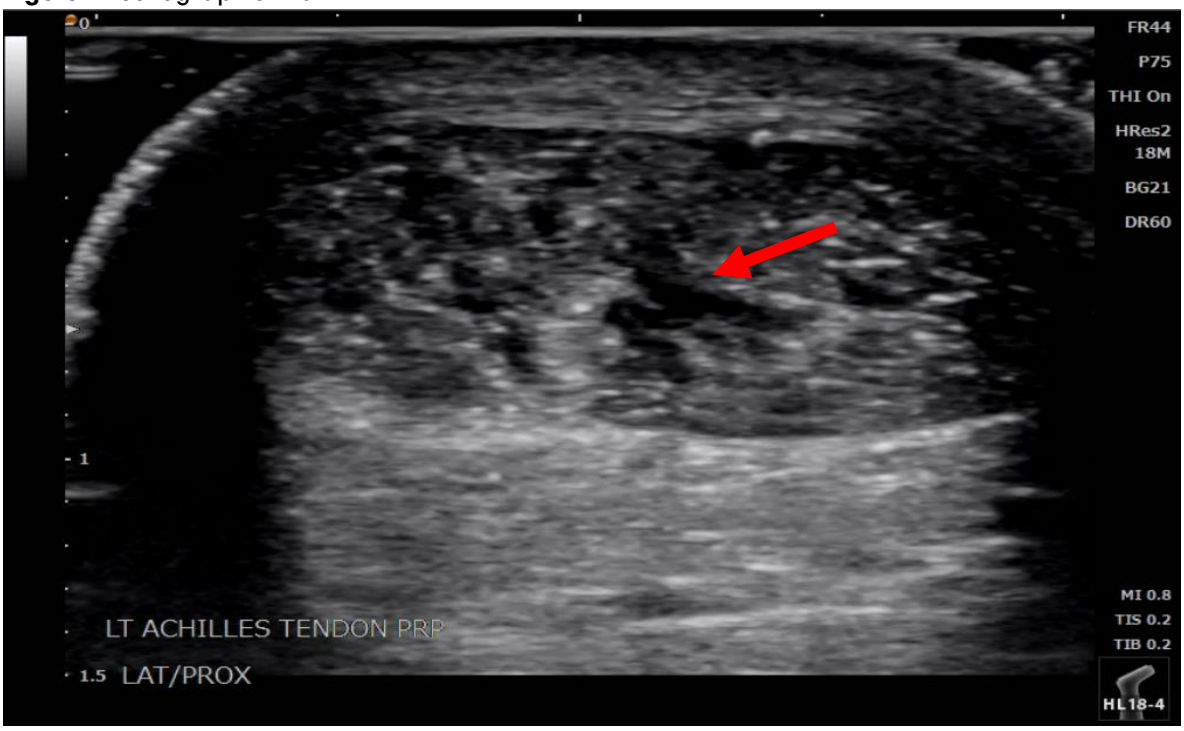
PATIENT HISTORY

A 32-year-old male professional ice hockey player sought evaluation for left ankle pain while wearing a Controlled Ankle Motion (CAM) boot. He initially experienced the pain several months prior while recreationally playing soccer. Both diagnostic ultrasound and magnetic resonance imaging (MRI) confirmed a partial Achilles tendon rupture. Prior to presentation, he underwent two injections with an IL-1Ra, engaged in physical therapy, and modified his activities. The patient described his pain as mild to moderate aching, aggravated by plantar flexion, and alleviated by icing and immobilization. He noted minimal to mild improvement with the two IL-1Ra injections and did not experience complete relief. The patient was utilizing oxycodone-paracetamol as needed for pain management. Physical exam was notable for midsubstance tenderness over the left Achilles tendon.

PRE-PROCEDURAL PLANNING

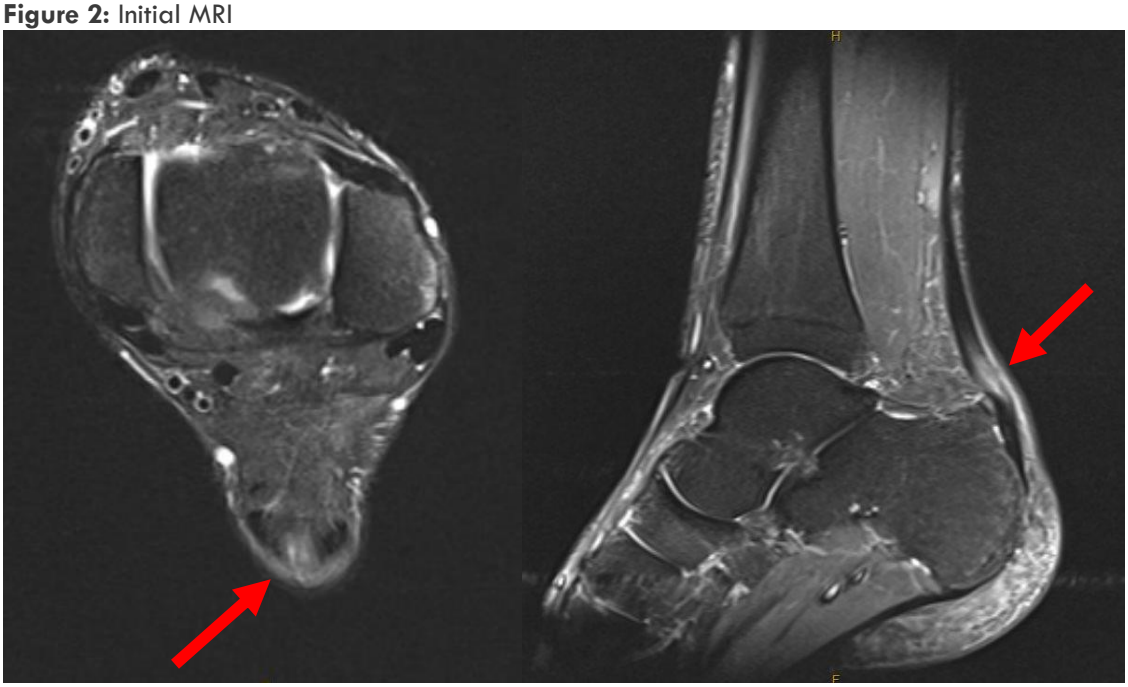
An ultrasound of the region was performed to confirm the location of the tear (Figure 1). An MRI of the left ankle showed a focal area of partial thickness tearing of the posterior central third of the tendon located 2.3cm proximal to the calcaneal insertion of the Achilles tendon. The tear measured approximately 1.5 cm in height x 0.5 cm in length x 0.5 cm in width. Notably, the MRI also revealed scarring of the anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL) which was indicative of prior injuries (Figure 2).

Figure 1: Sonographic Exam



Diagnostic ultrasound confirms a midsubstance partial Achilles tendon tear (red arrow).

Figure 2: Initial MRI



Left ankle T2 weighted axial and sagittal MRI imaging confirmed an intratendinous area of high signal intensity indicative of a partial Achilles tendon tear (red arrow).

Extensive discussions with the patient involved a thorough review of the risks and benefits associated with various treatment options. This included the consideration of managing the tear through surgical, conservative, and orthobiologic approaches, with an emphasis towards the off-label nature of orthobiologic treatment. The potential for an increased risk of rupture following an intratendinous procedure was also communicated. The patient elected to proceed with a PRP injection under ultrasound guidance. Prior to the procedure, the patient was advised to stop using any anti-inflammatory medication for two weeks and to refrain from its use for four weeks after the PRP injection.

PLATELET-RICH PLASMA PREPARATION

The procedure was carried out under sterile technique. Following informed consent, 25 mL of autologous blood was obtained from the antecubital fossa via standard venipuncture, and 5 mL of sodium citrate was added to prevent platelet activation and coagulation. An Emcyte Centrifuge (EmCyte Corporation, Fort Myers, FL) produced approximately 3 mL of autologous platelet-rich plasma after a double spin protocol. Hematologic analysis was performed via Mindray BC-3600 (Mindray North America, Mahwah, NJ) on a sample to determine the characteristics of the centrifuged injectate, as outlined in Table 1. The final product of platelet-rich plasma was subsequently injected into the target structure as described below.

Table 1: Hematologic Analysis

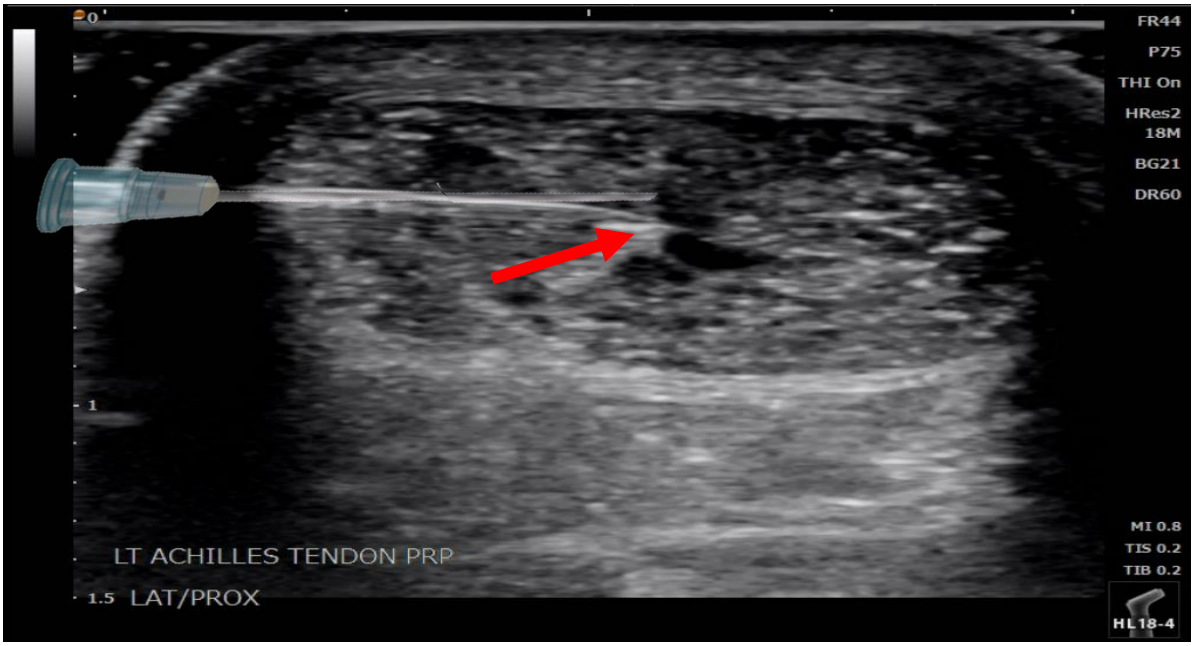
Whole Blood Volume Drawn: 25mL	
Sodium Citrate Anticoagulant Volume: 5mL	
Total PRP Kit Volume: 30 mL	
Analyzer Dilution Ratio: 4.8	
Final PRP Injection Volume: 3mL	
Whole Blood Analysis (pre-centrifugation)	**PRP Analysis (post-centrifugation)**
RBC 3.44 x10^6/µL	**RBC** 0.01 x10^6/µL
PLT 247 x10^3/µL	**PLT** 405 x10^3/µL
NEUT 2.9 x10^3/µL	**NEUT** 0.9 x10^3/µL
PCB = (405 x10^3/µL x 4.8) ÷ 247 x10^3/µL = **7.87 over baseline**	
TDP = (405 x10^3/µL x 4.8) x 3mL = 5,832x10^6 deliverable platelets	
RBCr = 100 – [(((0.01x10^6/µL x 4.8) x 3mL) ÷ (3.44x10^3/µL x 30mL)) x 100] = 99.86% RBCs removed	
TNVr = 100 – [(((0.9 x10^3/µL x 4.8) x 3mL) ÷ (2.9 x10^3/µL x 30mL)) x 100] = 88.10% NEUT removed	
PPC = [(405 x10^3/µL x 4.8 x 3mL) ÷ (247 x10^3/µL x 30mL)] x 100 = 78.70% PLT captured	

Hematologic Analysis performed via Mindray BC-3600 outlining the whole blood and post centrifuge injectate compositions. Figure Legend – RBC: red blood cells; PLT: platelets; NEUT: neutrophils; PCB: platelet concentration over baseline; TDP: total deliverable platelets; RBCr: red blood cells removed; TNVr: total neutrophil volume reduction; PPC: percentage platelets captured

INJECTION

The patient was placed in a prone position, an 18-4 MHz linear array ultrasound probe was used to localize the Achilles tendon tear, and the area was then marked and targeted for the procedure. Using a 25-gauge 1.5-inch needle, 0.5mL of 0.2% ropivacaine was employed to anesthetize the route to the target structure through a sonographically guided, in-plane, lateral-to-medial technique. Following the anesthesia, a 25-gauge 1.5-inch needle was advanced to the target structure (Figure 3), and 3 mL of autologous PRP was injected with excellent sonographic flow divided amongst several areas of the patient's Achilles tendon, while simultaneously tenotomizing the tendon. No complications were observed. The injection site was cleansed with alcohol swabs, and a band-aid was applied. The patient was instructed to remain in his CAM boot until the 2-week follow-up visit and was prescribed a 3-day course of oxycodone-paracetamol to take every 6 hours as needed for breakthrough pain.

Figure 3: Ultrasound Guided Injection



Sonographic imaging showing the needle tip (red arrow) entering the midsubstance tear of the left Achilles tendon. The left side of the image is the lateral aspect of the Achilles, while the bottom of the image is the proximal aspect of the patient's left lower extremity.

POST PROCEDURE FOLLOW-UP VISIT

At two weeks follow-up, the patient reported transient soreness for one-week post-injection that had since subsided. He wore a CAM boot for the entire two weeks. On examination, the patient reported reduced tenderness to palpation of the left Achilles tendon region compared to prior evaluation. The patient was instructed to discontinue CAM boot usage and to begin a focused physical therapy program.

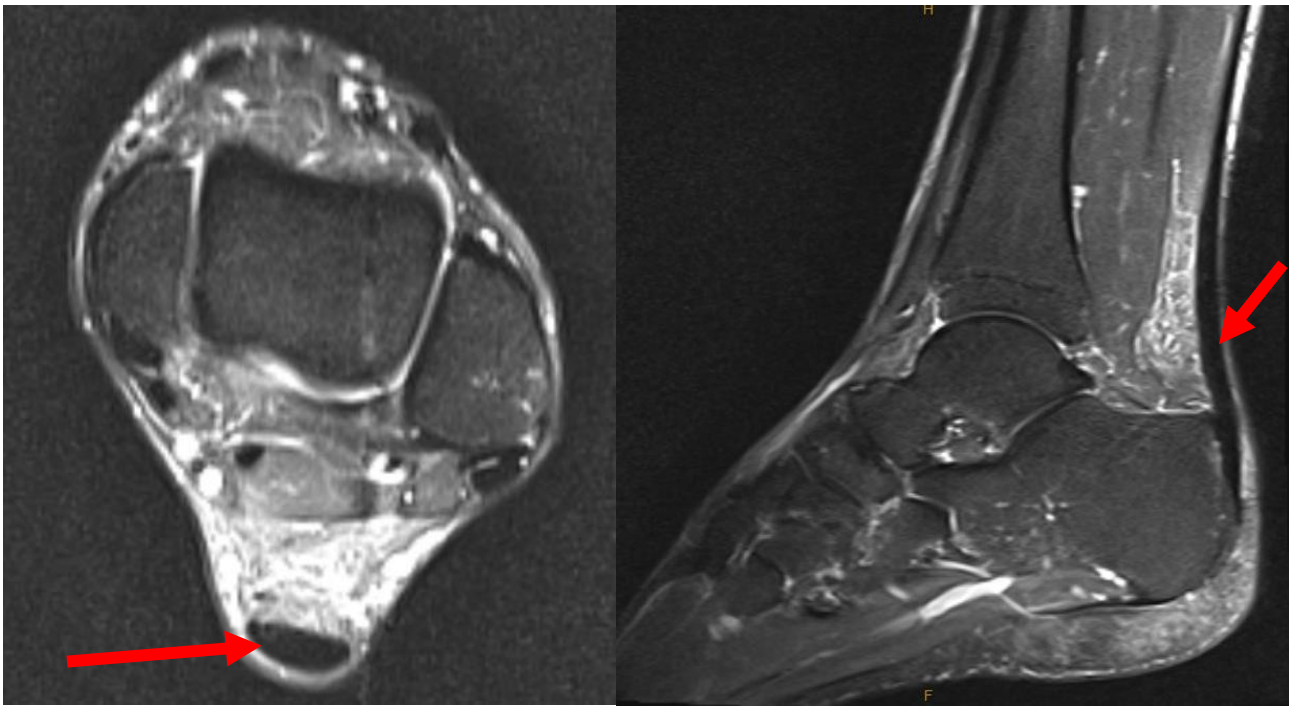
REHABILITATION PROTOCOL

To the best of the authors' knowledge, there are no existing comparison studies evaluating the effectiveness of post-PRP rehabilitation protocols on clinical outcomes. While NSAID restriction is standard practice after injection, the timing varies among providers, ranging from one to four weeks. Typically, post-PRP injection rehabilitation follows a three or four phase approach aligned with the stages of soft tissue healing: rest, activity restriction, and orthosis during the inflammatory stage; stretching and strengthening during the proliferation phase; and return to sport exercises in the remodeling phase.[15] During the two weeks in a CAM boot post-injection, the patient is expected to perform gentle active range of motion (AROM) exercises outside the boot multiple times daily.[16] After the initial 14 days, the patient can gradually incorporate strengthening exercises, starting with concentric activities and progressing to eccentric loading as symptoms allow.[16] During this period, the patient is advised to avoid high-velocity, high-amplitude, or intense exercise.[16] Finally, at 6-8 weeks, the patient should begin sport-specific activities while closely monitoring post-activity soreness, which should not exceed 24 hours.[16] It's crucial to highlight that while there are numerous standardized protocols, there is variation in the suggested interventions and the timing of their implementation.[15] This diversity largely stems from provider preferences, as well as differences in patients' progress rates influenced by factors such as age, health status, compliance, and the severity of the injury.[16]

POST PROCEDURE IMAGING

Follow-up MRI was obtained after the patient returned to high level competition which showed complete resolution of the tear (Figure 4). There are limited studies available with radiological evidence of acute partial Achilles tendon rupture. Sampson et al, reported a case of complete radiographic healing on follow-up MRI 3 months after PRP injection for an acute severe Achilles tendon rupture in a 71 year old male.[17] Additionally, Owens et al. performed pre and post PRP injection MRI imaging in six patients with chronic midsubstance Achilles tendinopathy and found complete resolution in only one patient at an average of 13.9 months following PRP injection.[18]

Figure 4: Follow-Up MRI

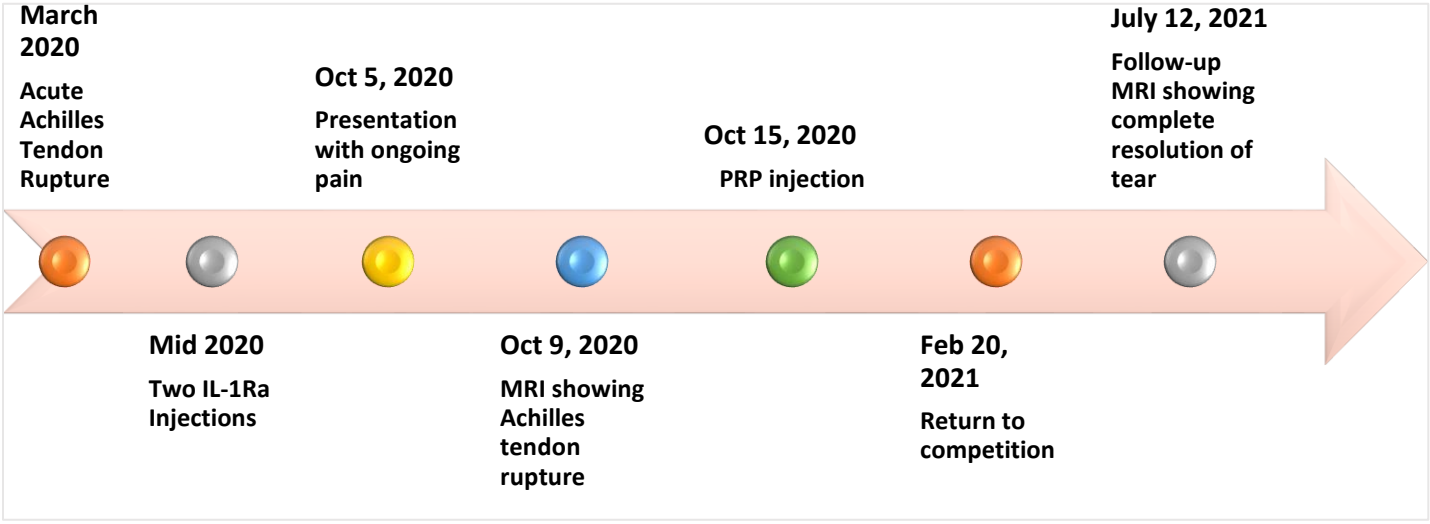


T2 axial and sagittal plane MRI follow-up imaging, conducted nine months after the initial MRI and PRP injection, revealing resolution of the partial Achilles tendon tear.

Discussion

This case report is primarily significant for presenting radiological evidence demonstrating the healing of an Achilles tendon rupture when treated with PRP—particularly noteworthy as the patient had initially presented with a subacute tear despite previous management with IL-1Ra injections. A variety of factors, both pre-to-post procedure, likely influenced these results. Refer to Figure 5 for a timeline detailing the progression from injury to the return to sport.

Figure 5: Case Report Timeline



Timeline from Achilles tendon rupture, return to sport, and the follow-up MRI showing resolution of the tear.

PRE-PROCEDURAL CONSIDERATIONS

Variability before the procedure involves factors such as prior IL-1Ra injections, the preparation of PRP, and determining its optimal concentration for maximum therapeutic benefit. While there is some evidence to suggest that IL-1Ra injections can be

effective in treating enthesopathies of the Achilles tendon,[19] the treatment did not produce satisfactory results in our patient, as evidenced by the radiographic presence of a partial Achilles tendon rupture and persistence of symptoms on presentation. As a result, the decision was made to pursue an alternative autologous conditioned serum via PRP. Factors to consider in PRP concentrate include ideal platelet (PLT) concentration, leukocyte rich (LR-PRP) vs leukocyte-poor (LP-PRP), erythrocyte quantity, and optional utilization of an activating agent such as calcium gluconate.

Previously, PRP concentrations of at least 1.5 x 10^6 platelets/µL were suggested to be sufficient for healing in musculoskeletal injuries.[20] Yet, in a recent systematic review of five randomized controlled trials that employed PRP for treating acute Achilles tendon ruptures, the effectiveness varied within a range of 4-6x baseline platelet concentration, though not all studies completed injectate analysis to confirm platelet concentration.[21] Some studies have found LP-PRP to be more effective and safer than LR-PRP when applied to intra-articular lesions,[22–24] though the generalizability of this application remains controversial for intra- and peri-tendinous application.[21] Studies with lower-level evidence, including case series and retrospective analyses amongst athletes, have demonstrated benefits of PRP for chronic Achilles tendinopathy.[20] PLT concentration factor (PLT-CF) in these studies ranged from 2.2-8.0, where PLT-CF is equal to the PLT concentration in PRP formulation divided by Serum PLT concentration.[20] Our patient presented with a unique scenario involving an acute Achilles tendon rupture after undergoing two previous orthobiologic injections. Sonographic and MRI assessments at the time of presentation confirmed the presence of a tendinous deficit (Figures 1 and 2). Following a discussion of the risks and benefits with the patient, a PRP injection was performed. As illustrated in Table 1, our patient received an injectate with a PLT concentration factor of 7.87 over baseline, falling within the suggested therapeutic range based on existing literature.

INJECTION CONSIDERATIONS

Important considerations for PRP injections in Achilles tendinopathy include the initial injection date in relation to the injury, the total number of PRP injections, and the time intervals between injections. Intraprocedural variations involve choosing between ultrasound versus landmark guided injections, inclusion or exclusion of needle tenotomy, and intra-tendinous versus peritendinous (or a combination of both) delivery of injectate.

Anatomically-guided injections are highly accurate given the superficial nature of the Achilles tendon.[25] However, as illustrated in Figure 3, ultrasound further enhances precision by facilitating precise needle placement for intra-tendinous or peritendinous PRP delivery and providing visualization for needle tenotomy.[26]

Concerning the timing and quantity of injections for acute injury, rat experiments have demonstrated enhanced tendon healing when PRP is immediately injected at a concentration of at least 3x the baseline.[27] Conversely, Delos et al discovered that delayed PRP injections in a rat gastrocnemius contusion model did not impact healing compared to immediate intervention with LR-PRP.[28]

In the setting of chronic Achilles tendinopathy, De Vos et al. and De Jonge et al. evaluated a single intra-tendinous LR-PRP injection compared to saline and found no significant difference between the groups.[29,30] However, in a 2017 randomized controlled trial (RCT) by Boeson et al., four peritendinous LP-PRP injections were administered, each two-weeks apart. Boeson found statistically significant improvements in the Victorian Institute of Sport Assessment-Achilles (VISA-A) score at 24 weeks and improvements in the Visual Analog Scale (VAS) at 6, 12, and 24-weeks.[26] Notably, none of the RCTs reported PLT-CF. In a recent systematic review, the PLT-CF for the non-significant studies by De Vos and De Jonge was estimated at PLT-CF = 9.3, while the statistically significant Boeson study had a PLT-CF = 2.5, based on device data from the products used in each study.[20]

Regarding the composition of PRP injections, Zhou et al. studied injuries to rabbit patellar tendons and found that the concentration of leukocytes can significantly impact the healing progression. The choice should be based on the stage of tendinous healing at the time of injection.[31] They discovered that both LR-PRP and LP-PRP induced the differentiation of tendon stem cells into active tenocytes and increased their proliferation. However, LR-PRP induced catabolic and inflammatory responses in differentiated tenocytes, whereas LP-PRP mostly augmented anabolic responses. The researchers concluded that LR-PRP should not be used in the treatment of chronic tendon injuries. Its application in such conditions may exacerbate tendon inflammation and degeneration, thereby impeding the healing of chronic tendon injuries. The authors suggested that LP-PRP could be used for late-stage healing, as in the case of our patient, because of its anabolic effects, enabling it to accelerate tendon healing.[31]

In the context of this case study, the patient underwent a single intra-tendinous LP-PRP injection following two IL-1Ra injections. Although the specific preparations of the prior orthobiologic treatments are unknown, it is reasonable to propose that a PRP injection administered during the subacute phase of healing could be beneficial, considering the favorable outcome observed in our patient. This suggestion aligns with findings from Boeson et al[26] as well as Zhou et al.[31] who indicated that LP-PRP might be suitable for late-stage healing due to its anabolic effects, allowing it to augment and accelerate tendon healing.[31]

POST-PROCEDURAL CONSIDERATIONS

The standardization of rehabilitation protocols following Achilles PRP injection is currently lacking. A consistent theme amongst studies is the use of an eccentric exercise program. There is, however, debate regarding the appropriate timeframe to initiate eccentric training programs after injection. Boeson et al. suggested gradual return to sports activities starting 10 days after injection, with progression monitored using a pain-based scale.[26] This differs from De Vos et al, where patients were instructed to avoid weight-bearing sports activities for the first 4 weeks.[30] Despite similar eccentric training programs between these two studies, De Vos et al. found higher VISA-A scores at 24 weeks in patients who avoided weight-bearing for 4 weeks, though this alone cannot definitively conclude a superior weight-bearing timeline post-injection. In addition to weight-bearing status and initiation of an eccentric therapy program, factors such as the duration of therapy, bracing, taping, and stretching influence the rehabilitation process. Similar to De Vos et al, our patient's rehabilitation included avoiding sport-related weight-bearing activity for 4 weeks post-injection. He remained in his CAM boot for 2 weeks after the procedure, with gradual return to weightbearing over the subsequent 2 weeks after removing the CAM boot protection.

RETURN-TO-SPORT

In a systematic review of 108 studies involving 6,506 athletes at various skill levels who experienced acute Achilles tendon rupture and underwent treatment using various methods, Zellers et al. found a lack of standardized measures for the rate and time to return to play. Nevertheless, they reported that 80% of all patients included in the review returned to play, with a mean return-to-play time of 6.0 months.[32] In comparison, our patient returned to play approximately 11 months following his initial injury and approximately 5 months after his PRP injection.

LIMITATIONS

This study is limited by several factors. Primarily, the unknown details of the patient's immediate post-injury care would provide additional insights into the feasibility of using PRP as a standalone treatment for acute Achilles tendon tears. Additionally, the generalizability of this case is challenging since it highlights the healing potential in an elite-level athlete closely monitored by medical professionals. However, despite these limitations, the radiological evidence of tendon healing supports further research into LP-PRP injections and indicates that the healing potential for an acute Achilles tendon rupture remains effective several months after the initial injury.

Conclusions

Ultrasound-guided LP-PRP injection may serve as an effective treatment option for partial acute Achilles tendon rupture during the subacute stages of tendinous healing, demonstrating complete radiographic resolution of the tear and enabling a return to high level athletics.

Conflicts of Interest Statement

The authors declare that they have no competing interests, personal or financial, that could influence or bias their work. They have not received any funding, equipment, or paid assignments from any organizations that may have a vested interest in the results or conclusions of the work presented in this manuscript.

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