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CASE REPORT

REHABILITATION OF A PARTIALLY TORN DISTAL TRICEPS TENDON AFTER PLATELET RICH PLASMA INJECTION: A CASE REPORT

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ABSTRACT

Background: Platelet Rich Plasma (PRP) is an emerging non-surgical intervention used for the treatment of tendon and ligament pathology. Despite the growing popularity of PRP in musculoskeletal medicine, there is a paucity of research that describes appropriate rehabilitation procedures following this intervention.

Case Description: This case report presents the rehabilitation strategy used following a PRP injection for a patient with a partially torn distal triceps tendon who previously failed physical therapy interventions.

Outcome: The patient returned to light weight training and coaching activity after completing 15 visits over a 3 month period. One month after discharge, the patient reported pain-free activities of daily living and a return to previously performed gym activities.

Discussion: PRP presents a viable treatment option for individuals who are recalcitrant to conservative interventions yet elect to avoid more invasive surgical measures. Despite the growing popularity of PRP, a paucity of evidence exists to guide physical therapists in the rehabilitation process of these patients. The rehabilitation strategies used in a patient who had a PRP injection for a partial triceps tendon tear are outlined. Although this case report highlights a successful rehabilitation outcome, future research regarding the concomitant effects of PRP injection and rehabilitation for tendon pathology are needed.

Key Words: Growth factor, platelet, stem cell

Level of Evidence: 4-Case Report

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BACKGROUND

Distal triceps tendon injuries are a relatively uncommon occurrence, with a majority of the epidemiological literature being descriptive, in the form of case reports. Although population-based surveys are not available to determine the prevalence of triceps injuries, data exists to identify the frequency of occurrence among individuals with upper extremity injuries.[1] Retrospective data from 801 consecutive magnetic resonance imaging examinations of the upper extremity and elbow identified distal triceps tendon injuries among 3.8% of subjects.[1] Although a majority of case reports in the literature focus on athletes, only 8% of the injuries identified by Koplas et al were athletically related.[1] Partial tears were most common comprising 23% of the distal triceps tendon injuries, with an average age of those injured being 46.8.[1] Although the mechanism of distal triceps tendon tears is multifactorial; trauma, athletic injury, weight-training, local corticosteroid injections, and the use of anabolic steroids have been implicated as primary risk factors.[1,2]

Management of distal triceps tendon injuries ranges from conservative intervention such as rest and immobilization to surgical repair. Surgical repair is often recommended for complete tears or partial tears with significant weakness of elbow extension.[2] Partial tears may be managed conservatively with traditional interventions being limited to rest and physical therapy.[2] Until recently there have been no interventions that fall between conservative management and surgical repair. Platelet rich plasma (PRP) may be a potential intervention for tendon and ligament injuries that are recalcitrant to conservative interventions.

PRP is a general term used to describe an autologous blood derived product that contains a concentration of platelets that is above baseline levels.[3-5] PRP preparations contain a myriad of molecular and cellular agents (proteins, electrolytes, hormones, biomarkers, alpha granules, dense bodies, lysosomes, neutrophils, monocytes, and erythrocytes) that act in a variety of pathways associated with healing.[6,7] Much of the initial use and investigation surrounding PRP was performed in the 1990's in the areas of maxillofacial and plastic surgery due to the high fibrin content found in these preparations. PRP began to be utilized in the clinical setting as early as the 1970's but not in the form of musculoskeletal injections.[3,4,8] Recently the use of PRP has gained increasing interest in the area of orthopedics and sports medicine for its proposed abilities to accelerate healing, antibacterial effects, and analgesic properties in both operative and non-operative treatments of musculoskeletal injuries. Of particular interest, is the use of PRP in the treatment of tendon and ligament injuries due to their poor vascularization and slower rate of healing.[5,9]

The preparation of PRP can be divided into three basic steps. First, autologous peripheral blood is withdrawn from the patient. Secondly, the blood is centrifuged to separate the plasma that is rich in platelets from the erythrocytes and leukocytes. Finally, the PRP preparation is either injected or intraoperatively applied to the target tissue.[4] There are several variables that differ in the preparation of PRP, which ultimately leads to differing platelet concentrations in the final preparation. These different variables include: peripheral blood volume drawn, the number and speed of centrifugations, the final volume of PRP, the use of an activator (e.g. collagen, thrombin and calcium), the use of anticoagulants, and the presence of leukocytes in the final preparation.[4,7] Boswell et al[6] found that even with consecutive blood draws from the same individual and preparations of PRP using the same system, the final preparation can yield varying concentrations of platelets. The findings mentioned above suggest both the peripheral blood drawn as well as the final PRP preparation should undergo a complete blood count to ensure that the final preparation contains all the molecular and cellular agents necessary to be considered PRP. Moreover, one must take this into consideration when evaluating the literature in this area. It should be noted that variations in the method of preparation might influence the ultimate outcome.

The evidence surrounding the use of PRP in the area of orthopedics and sports medicine is still very much in its infancy and the studies that do exist have yielded varying results. However, the population in which the application of PRP has shown to be effective in improving overall outcomes are those individuals that are refractory to conservative treatment measures.[10-13] Human clinical trials evaluating

the effect of PRP on ligament and tendon injuries involving both surgical and non-surgical procedures have been evaluated using levels of evidence from case series to prospective randomized control trials involving a variety of diagnoses.[10-23] Areas examined in these studies include ligament injuries to the anterior cruciate ligament (ACL) bone-patellar tendon-bone allografts, ACL hamstring allografts, achilles tendon ruptures and tendinopathy, patellar tendinopathy, elbow tendinopathy, and complete rotator cuff tears.[10-23] Interestingly, most of the available evidence for PRP supports its use with conservative care. With the increasing use of PRP in the area of orthopedics and sports medicine it is imperative that physical therapists and other rehabilitation professionals have an understanding of the procedure itself as well as how it potentially influences rehabilitation strategies used with patients who have undergone PRP treatments.

Therefore, the purpose of this case report is to describe the rehabilitation strategy used following a PRP injection for a patient with a partially torn distal triceps tendon tear who previously failed physical therapy interventions.

CASE DESCRIPTION

Patient Demographics

The patient was a 47-year-old male accountant who coached youth football and participated in weight-training 2 to 3 times a week prior to injury. His medical history was unremarkable for a previous upper extremity musculoskeletal injury. He did have hypertension and hypercholesterolemia which was managed with Lisinopril, aspirin (81 mg), and Lipitor®. He denied using over the counter or prescription supplementation to enhance weight-training performance.

Injury Onset and Medical Diagnosis

The patient reported injuring his left elbow in April 2011 while lifting a box overhead estimated to weigh 40lbs. At the time of initial injury he felt an "intense" pain in his distal left triceps. He initially managed the pain with ice and heat; however, increasing pain and weakness prompted him to see an orthopaedic surgeon approximately 1 week after the incident. He was subsequently referred for a magnetic resonance imaging (MRI) scan without contrast (Optima MR450w 1.5T GE) which indicated a partial thickness tear of the distal left triceps tendon (Figure 1). The patient was subsequently referred to physical therapy.

INITIAL EXAMINATION

The patient was seen for the initial physical therapy examination in May 2011. The examination and subsequent interventions were carried out by a physical therapist with 8 years of experience and a board certification in orthopaedics. His examination findings are outlined below.

Subjective

The patient presented to physical therapy stating he had not used his left elbow for any activities of daily living due to pain and weakness. He reported being right side-dominant and stated as a result he has not attempted to use his left elbow since the initial injury. His primary goals were to return to pain-free physical activity and begin coaching youth football in the fall. The patient complained of pain in the posterior aspect of his left elbow near the insertion of the triceps tendon. An 11-point numerical pain rating scale (NPRS) with 0 (no pain) to 10 (worst pain imaginable) was used to elicit an objective ranking of the patient's pain level.[24,25] During the past 24 hours, the patient reported his pain to be 7/10 at worse and

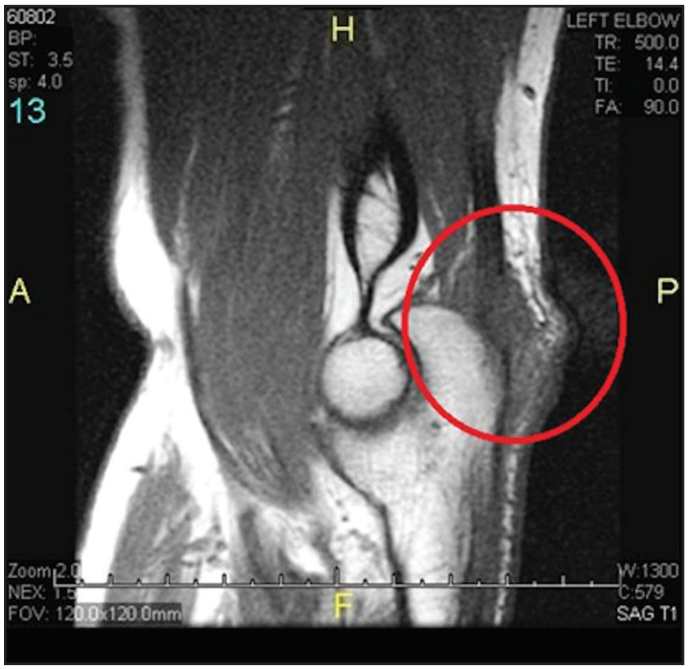

Figure 1. *MRI sagittal TI image of the partially torn left distal triceps tendon, as noted by the colored oval.*

0/10 at best. At the time of the examination his pain was rated a 2/10. He stated his pain was 7/10 with movements that activated the triceps muscle (e.g. pushing tasks) and was 0/10 when supporting his elbow at his side. He denied pain or discomfort at the neighboring joints and had no reports of parasthesias or general malaise.

Observation and Structural Inspection

The patient presented in no acute distress and had no constitutional signs or symptoms. He had a mixed endomorphic-mesomorphic build (Body mass - 86.18 kg, Height - 175.3 cm, Body Mass Index - 28.1 kg/m^2). Integumentary inspection was unremarkable with no evident ecchymosis or erythema; however non pitting-edema was noted at distal elbow just proximal to the olecranon process. He presented with guarding of the left upper extremity demonstrated by positioning the extremity close to his body. A normal carrying angle was noted with no structural asymmetries once he assumed a relaxed posture.

Range of Motion and Muscle Performance

The patient's elbow and wrist range of motion (ROM) were tested bilaterally both actively and passively as described by Norkin & White.[26] All measurements were within normal limits (WNL) and symmetrical with the exception of the left elbow. The patient was apprehensive with movement of the left elbow but agreed to perform both active range of motion (AROM) and passive range of motion (PROM). AROM of the left elbow revealed flexion to 90 degrees with a 5 degree loss of elbow extension. PROM was equal to AROM with painful end-feels and no tissue resistance (empty end-feel). AROM of the shoulder was symmetrical and pain-free for flexion and extension, thus passive testing was not performed. Shoulder internal and external rotation ROM was deferred given the patients report of pain with elbow flexion.

Muscle performance of the upper extremities was quantified (Table 1) using manual muscle testing as described by Hislop and Montgomery.[27] The left triceps was graded a 3/5, however no additional resistance testing was performed due to the presence of pain.

Palpation

Palpation of the left elbow region was assessed using a 5 point pain scale (Grade 0-4) as described by Hubbard & Berkoff.[28] The grading criterion is as follows: grade 0- no tenderness, grade I- mild tenderness without grimace or flinch, grade II- moderate tenderness plus grimace or flinch, grade III- severe tenderness plus marked flinch or withdrawal, grade IV- unbearable tenderness, patient withdrawals with light touch.[28] Palpation of the patient's left elbow

Table 1. *Muscle Performance Testing Prior to PRP Injection, 4-weeks Following Injection, and at Discharge.*

	Pre-PRP		4-weeks Post-Injection		Discharge	
Muscle Groups Tested	Right	**Left**	Right	**Left**	Right	**Left**
Shoulder Internal Rotation	*4+/5*	*4+/5*	*4+/5*	*4+/5*	*5/5*	*5/5*
Shoulder External Rotation	*4+/5*	*4+/5*	*4+/5*	*4+/5*	*5/5*	*5/5*
Shoulder Flexion	*5/5*	*5/5*	*5/5*	*5/5*	*5/5*	*5/5*
Elbow Flexion	*5/5*	*3+/5*	*5/5*	*4/5*	*5/5*	*5/5*
Elbow Extension	*5/5*	*3/5*	*5/5*	*4-/5*	*5/5*	*5/5*
Wrist Flexion	*5/5*	*5/5*	*5/5*	*5/5*	*5/5*	*5/5*
Wrist Extension	*5/5*	*5/5*	*5/5*	*5/5*	*5/5*	*5/5*
Forearm Supination	*5/5*	*5/5*	*5/5*	*5/5*	*5/5*	*5/5*
Forearm Pronation	*5/5*	*5/5*	*5/5*	*5/5*	*5/5*	*5/5*

* PRP: Platelet rich plasma

revealed grade III (severe) tenderness along the triceps muscle belly and distal triceps tendon insertion. Palpation of the distal tendon at the olecranon insertion revealed a palpable defect with non-pitting edema. Temperature was symmetrical throughout the elbow with the exception of increased warmth at the posterior elbow. The distal radial pulse was normal bilaterally as was digital capillary refill.

Special Testing

Select special testing of the elbow was conducted to rule out any underlying impairments or pathology that may have been elusive to MRI. Elbow varus and valgus tests were both negative for structural instability of the collateral ligaments.[29] Muscle length testing was performed to determine the nature of the patient's elbow extension loss and revealed length impairments of both the biceps and forearm flexor/pronator group. Muscle length of the supinator group was not impaired. Muscle length testing was deferred at the triceps.

Assessment and Evaluation

At the time of the initial examination, the patient was approximately one month post-injury with obvious disuse of the left upper extremity as a result of the partial triceps tendon tear. The impairments and functional limitations combined with the mechanism of injury were consistent with a partial tear of the distal triceps tendon.[1] Additionally, the examination findings were consistent with Practice Pattern E from the Guide to Physical Therapist Practice: *Impaired Joint Mobility, Muscle performance, and Range of Motion Associated With Ligament or Other Connective Tissue Disorders*.[30] It was determined that the patient would benefit from a conservative course of physical therapy in order to reduce pain, mitigate impairments and address functional limitations.

INTERVENTION PLAN

The patient underwent 5 visits of physical therapy (Pre-PRP phase, located in Table 2) over a 4-week duration. At 4-weeks the patient reported an overall improvement of 60% with activities of daily living (ADL) & work activity (based on verbal response to query), however, he still complained of persistent pain rated a 6/10 with activities that activated his triceps. The change in the NPRS of 1-point from a 7/10 is not considered a clinically important change.[24] His elbow ROM was unchanged at 90 degrees of flexion; however, he had restored full elbow extension. Muscle performance of the triceps remained a 3/5, and tenderness decreased to a grade II (moderate) along the distal triceps tendon insertion. Given persistent impairments and pain, the patient was referred back to the orthopedic surgeon who subsequently determined that a PRP injection was the best course of action.

PRP Injection

The patient underwent a single PRP injection 5 weeks after the original injury by his orthopaedic surgeon. The patient's blood was drawn (10cc) and spun using the Arthrex® platelet-rich plasma centrifuge (Arthrex, Naples, FL). The PRP component was then injected into the defect in the distal triceps tendon. The patient was advised to rest for 2-weeks and avoid non-steroidal anti-inflammatory drugs (NSAIDs) and ice for 4 weeks. It has been postulated that ice and the use of NSAIDs may interfere with the healing potential of PRP.[31]

Re-Examination

The patient returned to physical therapy 2-weeks after the PRP injection and a formal re-examination was performed. Re-examination findings revealed decreased pain to a 3/10 at worse and 0/10 at rest. Elbow ROM had not changed from 0-90 degrees; however the patient was able to tolerate resisted muscle testing of the triceps with a 3+/5 recorded. Tenderness was unchanged at grade II.

Phase I: Rehabilitation Post Injection

After PRP injection, the referring physician recommended 2-weeks of rest followed by a gradual return to physical activity. The 2-week rest period is based on early inflammatory responses seen following PRP as well as the work of de Vos et al.[23] Phase I rehabilitation began 2-weeks after the injection and included 2 weeks of active and passive range of motion, strengthening exercises with resistance bands and dumbbells, soft tissue mobilization, and electrotherapy (for pain) (Table 2). The patient's home program consisted of once daily pain free AROM & PROM elbow flexion and extension, as well as basic isotonic strengthening and stretching of the wrist musculature. The patient was seen for 4 visits over the 2-week period.

Table 2. *Rehabilitation Program.*

Timeline	Program Details
Pre-PRP Phase	**ROM:** Pain free AROM & PROM exercise for the upper extremity including elbow flexion and extension as well as wrist AROM all planes. Upper body ergometer with lightest resistance **Strengthening:** Periscapular and rotator cuff muscle strengthening (using resistance bands), wrist and forearm strengthening all planes (using dumbbells), bicep curls using a weight that allowed 20 repetitions **Manual Therapy:** Soft tissue management of the left upper extremity with emphasis on the triceps, biceps, and posterior scapular muscles. **Stretching:** General stretching for the left biceps and forearm musculature. **Modalities:** Ice with electrotherapy **Home Program**: Pain-free AROM & PROM of elbow, UE strengthening and basic stretching of wrist and forearm all planes (excluding triceps).
	Plasma Rich Protein Injection Procedure
2 weeks post-injection	**Rest Phase**
Post-PRP Phase I 2 -4 weeks post-injection	**ROM:** Pain free AROM & PROM exercise for the upper extremity including elbow flexion and extension as well as wrist AROM all planes. AROM activity using upper body ergometer (light to moderate resistance). **Strengthening:** Periscapular and rotator cuff muscle strengthening (using resistance bands), wrist and forearm strengthening (using dumbbells), bicep curls using a weight that allowed 3-sets of 12-20 repetitions with 30-second rest periods in an attempt to restore muscular endurance[42] **Manual Therapy:** Soft tissue management of the left upper extremity with emphasis on the triceps. **Stretching:** General stretching for the UE **Modalities:** Electrotherapy for pain management **Home Program**: Pain free AROM & PROM (with other UE) elbow flexion and extension, UE strengthening and stretching of wrist musculature all planes with elbow flexed at 90° **Progression to Phase II:** Progression was dependent upon improvement in impairments from Phase I and the absence of pain following each routine. Pain experienced the next day was considered acceptable.
Post-PRP Phase II (4 weeks post- injection)	**ROM:** Continuation of pain-free AROM as needed. AROM activity using the upper body ergometer for conditioning with progression of resistance. **Strengthening**: General upper extremity strengthening using the physioball, dumbbells, and bodyblade®. Concentric and eccentric strengthening for left triceps with cables and dumbbells. Concentric resistance training was performed initially with a weight that allowed 3 sets of 12-20 repetitions with 30 second rest periods for endurance and was progressed to a weight that allowed 6-12 repetitions with rest periods of 90-seconds for hypertrophy.[42] Additionally, strengthening of the triceps was monitored closely as weight was not progressed until patient reported ability to perform given set with no pain at conclusion. **Eccentric activities:** At conclusion of concentric exercises patient performed resistance training using the eccentric only phase with a weight that allowed 15-30 repetitions for 1-3 sets. Assistance with concentric phase was from therapist or patient's contralateral extremity. **Manual Therapy:** Continued soft tissue management of the left upper extremity with emphasis on the triceps. **Stretching:** Continued stretching for the upper extremity, as needed **Modalities:** Ice with electrotherapy **Home Program**: Return to pain free gym activity including pre-morbid upper and lower body exercises for the major muscle groups using free weights and machines with slow progression of triceps exercises using cables or dumbbells.
AROM: active range of motion, PROM: passive range of motion, UE: upper extremity	

At the conclusion of Phase 1, the patient continued to report pain rated a 3/10 at worse and 0/10 at rest, however, the patient stated that his threshold for reproducing pain had changed and that he was able to push off his left upper extremity for activities such as rising from a chair. AROM elbow flexion had improved to 105° with PROM to 110°. Manual muscle testing of triceps was graded a 4-/5 (Table 1).

Phase II: Rehabilitation

Phase II began 4-weeks after the injection. In addition to temporal factors, progression to phase II was dependent upon performance of phase I exercises without post-exercise soreness as well as continued improvement in mobility and strength. The patient was seen for 6 visits over 4-weeks. In phase II (Table 2) activities were advanced to include physioball activity, the Bodyblade®, and muscle strengthening tasks using resistance bands and dumbbells. Concentric activity was introduced for the left triceps, during the first 2 weeks in phase II (week 4-6 post injection) and then isolated eccentric activity was introduced for further strengthening from the 6-week post injection period until discharge. Although de Vos et al advocate beginning eccentric activity at 2-weeks post PRP injection their work was based on a cohort with tendinopathy.[23] The progression was slower with this patient given the nature of the injury (partial tear). Manual therapy continued with soft tissue mobilization of the triceps and shoulder musculature, as needed. The patient's home program progressed to pain-free upper and lower body exercises for the major muscle groups using free weights and machines and slow progression of triceps resistance activity using both concentric and eccentric exercises (Table 2).

OUTCOMES

Discharge

The patient met all goals for physical therapy and was discharged after completing 15 visits over a 3-month period. At discharge the patient reported 0/10 pain with activities of daily living, light weight training, and coaching activity which far exceeded the 2-point minimal clinically important difference (MCID)[24] for the NPRS. Pain was rated at 2/10 with triceps strengthening while at the gym. The left elbow had full pain-free ROM and all upper extremity manual muscle tests were graded a 5/5. Muscle length & myofascial mobility was normal in the triceps and biceps at discharge.

Follow-Up (1-month)

One month after discharge, the patient was contacted via phone and reported normal daily activity with 0/10 pain. The patient reported pain-free gym activity including weight-training and cardiovascular activity. Continued pain, rated at 2/10, was reported during resistance training that targeted the triceps musculature however, symptoms resolved after the activity.

DISCUSSION

This case report describes the care of a patient that falls within the average age, gender, and injury mechanism for a distal triceps tendon injury[1] who elected to undergo PRP injection as an intervention in an attempt to avoid surgery. He was recalcitrant to physical therapy initially; however, following one PRP injection and a 2-week period of rest he successfully completed a 6-week course of physical therapy and returned to premorbid activities pain-free and without limitations.

Several studies investigating the use of PRP to promote tendon healing have found significant improvements in various outcome measures among patients[11,16-18,21-23] However, few of these studies mention the rehabilitation process and or activity level of these individuals following the PRP injection(s).[10,11,22,23,32] This component of the recovery process is necessary to understand the physiological healing mechanisms (upregulation of growth factors and autocrine secretion of anabolic hormones one would experience from eccentric training) that work in conjunction with PRP injections for optimal outcomes. The studies that do mention rehabilitation as a necessary component following PRP injections simply refer to the use of a standard rehabilitation protocol with little detail regarding the interventions that were implemented. Kon et al[22] briefly describe a progressive manner of return to activity in which the individual rests between the first and second injection (2-weeks apart) and then begins with stretching after the second injection to the patellar tendon, followed by advancement to strengthening and return to sport in one month. de Vos et al[23]

provide somewhat greater detail in regards to the rehabilitation following PRP injection of the achilles tendon including the specific number of eccentric repetitions performed. These details related to the rehabilitation process are necessary following PRP injections, as they are an important variable to be considered if clinicians intend to reproduce results among a similar patient population.

The success of the patient in this case report may have been, in part, the result of the PRP injection which is believed to provide the benefits of recruitment, proliferation and differentiation of cells involved in tissue regeneration.[5] A key goal of the intervention described herein was to address the patient's impairments, while providing a favorable environment for healing. The authors of this case report commonly see a post-injection inflammatory response and believe that rest was important initially following the injection. Upon resuming physical therapy certain measures were used to ensure an inflammatory process was not created, particularly in light of the orthopaedic surgeon's protocol which included no ice and anti-inflammatory medications for 4-weeks. Essentially, lower level activities were performed early on and the authors' used soreness as a means of guiding the progression of interventions. Activities that produced next day soreness were deemed favorable as the benefit was likely the result of delayed onset muscle soreness which has been associated with muscle remodeling and hypertrophy.[33] Soreness that was reported immediately following, or the evening of physical therapy was considered adverse and the routine was adjusted appropriately. On two occasions in Phase 1 and one occasion of Phase 2 the patient reported soreness that developed within an hour of leaving therapy. In both instances the resistance training component of the intervention was deferred for one visit and resumed the next visit without detriment.

A key component to the rehabilitation was the incorporation of eccentric activities 4-weeks after PRP injection. Specifically, evidence exists to suggest that eccentric training induces a favorable benefit on muscle strength,[34] hypertrophy,[34] as well as stimulation of anabolic hormones and growth differentiation factors, when compared to isometric and concentric based training.[35] Moreover, the efficacy of eccentric training for reversing degenerative changes in tendons,[36,37] improving function[38-40] as well as decreasing pain[37,39] has been reported in clinical investigations. Given the likelihood of increased soreness following eccentric activities[41] the authors withheld this routine until the 4-week post-injection stage. Once eccentric activities were initiated the patient's soreness was closely monitored. Eccentric activities were only progressed when the patient did not report same day soreness following the previous routine.

A limitation of the rehabilitation strategy described in this case report is the paucity of supporting research that identifies specific temporal factors for healing. The authors of this study routinely manage patients following PRP procedures performed in their offices by orthopaedic surgeons, and therefore have developed a consensus as to milestones that were utilized with this patient. Future comparison based research is needed to determine the efficacy of the proposed timelines as well as the efficacy of specific interventions used, such as eccentric training.

CONCLUSION

The existing evidence surrounding the use of PRP is still emerging, and has mixed results**.** PRP may present a viable option for individuals who are recalcitrant to conservative interventions yet elect to avoid more invasive surgical measures. Despite the growing popularity of PRP, a paucity of evidence exists to guide physical therapists in the rehabilitation process of these patients following injection. The rehabilitation strategies used in a patient who had a PRP injection for a partial triceps tendon tear are outlined. Although this case report highlights a successful rehabilitation outcome, future research regarding the concomitant effects of PRP injection and rehabilitation for tendon pathology are needed.

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