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MINIREVIEWS

Role of platelet-rich plasma in the treatment of rotator cuff tendinopathy

Ausberto Velasquez Garcia, Liborio Ingala Martini, Andres Franco Abache, Glen Abdo

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Abstract

Shoulder pain is a common musculoskeletal complaint, and rotator cuff (RC) pathologies are one of the main causes. The RC undergoes various tendinopathic and avascular changes during the aging process. Other degenerative changes affecting its healing potential make it an appealing target for biological agents. Platelet-rich plasma (PRP) has demonstrated the potential to deliver a high concentration of several growth factors and anti-inflammatory mediators, and its clinical use is mainly supported by experiments that demonstrated its positive effect on muscle, ligaments, and tendinous cells. This review aimed to specify the role of PRP and its future applications in RC tendinopathies based on the current clinical evidence. Due to the different characteristics and conflicting outcomes, clinicians should use PRP with moderate expectations until more consistent evidence is available. However, it is reasonable to consider PRP in patients with contraindications to corticosteroid injections or those with risk factors for inadequate healing. Its autologous origin makes it a safe treatment, and its characteristics make it a promising option for treating RC tendinopathy, but the efficacy has yet to be established.

Key Words: Rotator cuff; Tendinopathy; Platelet-rich plasma; Shoulder pain; Nonoperative

treatment; Injectables

Core Tip: Platelet-rich plasma may be a promising treatment option for rotator cuff tendinopathy, but more consistent evidence is needed to establish its effectiveness. Therefore, clinicians should approach its use with moderate expectations and consider it a potential treatment option for patients who cannot receive corticosteroid injections or have risk factors for poor healing.

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INTRODUCTION

Shoulder pain and disability are common musculoskeletal complaints caused mainly by rotator cuff (RC) lesions[1]. Aging can promote the development of many tendinopathic and avascular changes in RC, altering its intrinsic healing capacity and increasing failure rates after surgical or non-surgical treatment[2]. RC lesions include a wide range of pathological states, beginning with acute tendinitis and progressing to tendinosis, degeneration, partial-thickness, and full-thickness tears[2,3]. Full-thickness RC tears represent the end stage of RC pathology and have an incidence of approximately 20% in adults. The prevalence of these tears increases to over 50% after the age of 60 years[4-6].

To ensure accurate management and effective communication among clinicians, it is necessary to establish a clear definition for tendinitis and tendinosis[7,8]. Tendinitis is associated with inflammation, stress, degeneration, and poor mechanics and is generally caused by overuse[9]. Tendinosis encompasses tendon degeneration with or without histological signs of inflammation, including impaired and disorganized collagen, increased vascularity, and cellularity[9, 10]. In general, tendinopathy is a term attributed to different tendons pathologies with various etiological factors, mainly caused by overuse, that can cause discomfort when the tissue does not regenerate[7,11].

New biological therapies aim to improve tendon healing as part of the ongoing development for the treatment of RC tendinopathy. These therapies include platelet-rich plasma (PRP) injections, growth factors, mesenchymal stem cells (MSCs), adipose-derived, and bone marrow aspirate concentrate. These have been proposed to speed up tendon recovery based on encouraging results from experimental models and clinical trials[12,13]. Therefore, a wide range of the states of RC tendinopathy may be effectively treated with nonoperative treatment, particularly in those where the structural integrity of the tendon has not been fully involved[14]. This review aimed to summarize the current evidence for the effectiveness of PRP as a non-surgical treatment method for RC tendinopathy.

ETIOLOGY AND SYMPTOMS OF RC TENDINOPATHY

Several theories have described possible pathophysiological routes for RC tendinopathy. Intrinsic and extrinsic mechanisms have traditionally been associated with the development of RC tendinopathy[2]. Widely studied, the intrinsic pathway describes degeneration due to hypoperfusion of the RC tendons, cell degeneration, and apoptosis, and some authors state that these create the main link in the establishment of tendinopathy[2]. Extrinsic factors are related to mechanical theories, in which microtears occur due to overuse or repetition[15]. Disorders associated with biomechanical causes, such as chronic impingement, superior humeral head translation, and overuse, have been associated with progressive degeneration of the RC tendons[2]. Since the underlying mechanism or tendon pathology cannot be determined in routine clinical practice, tendinopathy is a common term that involves many different clinical diagnoses [16].

RC tendinopathy, including partial-thickness tears, could cause limited shoulder motion, discomfort at rest, a painful arc of motion, and external rotation weakness. It is common to cause symptoms with painful overhead and positive special testing[16]. Furthermore, sleep disturbances may be characterized by discomfort in the mid-lateral region of the humerus or the anterolateral aspect of the acromion[7,8]. Indeed, partial tears are usually more painful than full-thickness [17].

TENDON HEALING

Regardless of the type of treatment applied, tendon healing occurs in three overlapping phases: Inflammatory, proliferative, and remodeling[18]. The inflammatory process produces cytokines near the injury site in the first 24 to 48 h,

attracting neutrophils, macrophages, and red blood cells. The healing process continues with hematoma formation and cellular invasion into the surrounding areas of the tendon. Growth factors, such as platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), and vascular endothelial growth factor, are released by platelets during this phase[19-21].

During the proliferative phase, MSCs migrate and differentiate, influenced by PDGFs[18]. The cells involved in tissue repair, such as fibroblasts and MSCs, proliferate and synthesize extracellular matrix (ECM) proteins[19-23]. Fibroblasts that migrate during this phase generate type III collagen and glycosaminoglycans, which enhances the tissue's tensile strength, elasticity, and lubrication[24,25]. Tenocytes become the primary cell type responsible for producing and maintaining the ECM proteins that provide the necessary structure and mechanical properties to form new tissue[19].

Collagen cross-linking increases during the remodeling phase, and collagen type III is reabsorbed and replaced, resulting in an improved organization[25]. During this stage, tenocytes produce ECM proteins and other signaling molecules that amplify the upregulation of collagen type I gene expression and optimize the structure and function of the newly formed tissue[19,20,22,23]. However, complete tendon regeneration is not achieved, and the complex remodeling process usually leads to a steady decrease in tendon biomechanical strength[18,24]. Figure 1 illustrates the role of PRP in different stages of tendon healing.

CLINICAL EVIDENCE OF PRP INJECTIONS

Overall, clinical findings suggest that PRP injections for musculoskeletal pathologies, including supraspinatus tendinopathy, are safe[26], cost-effective, and easily administered outpatient procedures providing promising results compared to other treatment options[3]. The efficacy of various types of PRP is currently being evaluated in the shoulder and other joints[27]. Previous reports have shown inconsistent outcomes, with superior results in the PRP-treated group compared to the control groups, while others have shown similar or even inferior results[28-31]. The variability in the preparation techniques for PRP may explain the wide range of effectiveness among various studies[32]. Furthermore, factors such as the number of platelets available and the presence of anticoagulants and activators can significantly impact the growth factors present in the final PRP composition. As a result, it is difficult to compare research studies that differ substantially in design and methodology[33-35]. Furthermore, the intrinsic heterogeneity in the final composition of PRP and the various elements involved have been recognized as the main limitation of PRP injections for their wide recommendation in clinical practice[36-40].

Since these studies used different procedures to obtain the final PRP and varied the concentration of platelets and other components, the clinical results are inconsistent. This compositional variation can affect the advantages of a hypothetical healing effect[41]. Furthermore, factors such as concurrent physical therapy, exercise programs, and the impact of needle stimulation can contribute to some bias, which could also affect outcomes[42].

PRP IN TENDINOPATHIES

Natural growth factors, cytokines, and anti-inflammatory mediators are used in orthopedics to treat and recover tissues involved in diseases. As a result, a significant increase in the use of biological agents to treat common musculoskeletal injuries has been observed in recent years[43]. Different disorders have been treated with PRP, MSCs obtained from bone marrow aspirates, and adipose tissue[43]. PRP has gained recent popularity for treating shoulder disorders in clinical practice and as a viable method to enhance the surgical treatment of RC tears[44]. However, due to conflicting results, clinicians are still skeptical about the actual benefit and optimal use of these treatments in common shoulder diseases[43].

The clinical use of PRP is mainly supported by *in vitro* experiments that demonstrated its positive effect on muscle and tendinous cells[45]. Tenocytes exhibit enhanced proliferation and ECM production, improving tendon recovery. Additionally, when exposed to PRP, stem cells are stimulated to differentiate into tenocytes[45-48]. These characteristics show that PRP might enhance human tenocyte healing through cell proliferation and encourage ECM production[49]. Consequently, PRP could be a highly appealing therapy option for RC tendinopathy[49].

Authors in recent years have encompassed a wide range of preparations, presentations, and formulations under the term PRP. From a bioanalytical point of view, PRP consists of a fraction of whole blood with a supraphysiological concentration of platelets and other components[44]. The PRP therapy preparation process involves the separation of platelets from whole blood by centrifugation. In addition, platelet-activating chemicals can be added to enhance the effectiveness of the therapy. The growth factors released from the platelet alpha granules, approximately 7-10 d after PRP administration, coincide with the inflammation and healing phases of the tendon, promoting cellular differentiation and the healing process[32,50,51].

Growth factors, inflammatory mediators, and proteins that promote stromal and MSCs growth, including those derived from tendons, multiply once activated and hinder the repair process by creating fibrous scar tissue instead of healthy tissue[44]. Studies have shown that PRP injections can improve the structure of the ECM of tendons in the short term when injected directly into the tissue and administered through a matrix scaffold. This tendon healing and regeneration mechanism may be responsible for the clinical and structural improvements of the tendons after PRP therapy[28,33,44,52].

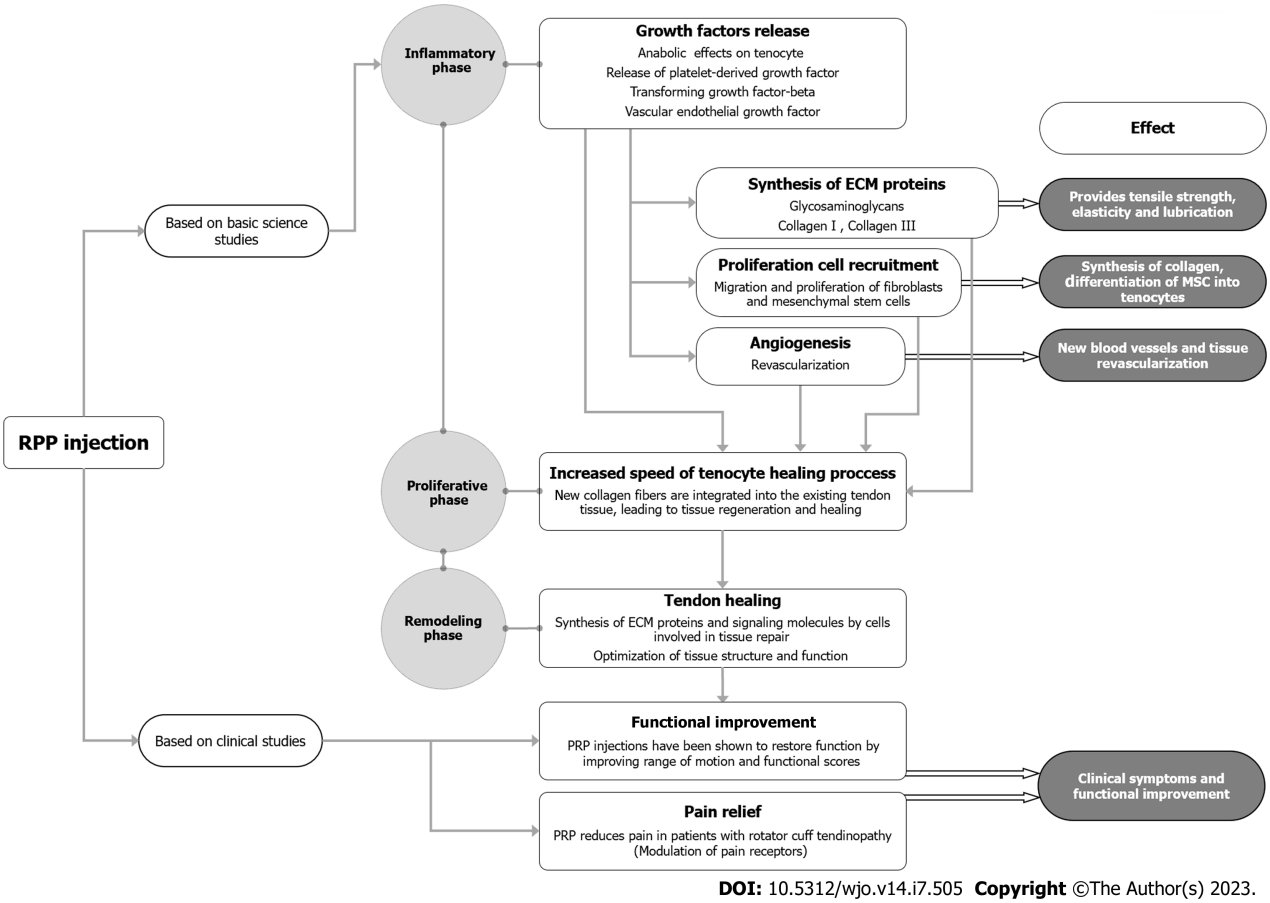

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Figure 1 The potential role of platelet-rich plasma in different stages of tendon healing. PRP: Platelet-rich plasma; ECM: Extracellular matrix.

PRP FOR RC TENDINOPATHY

PRP vs placebo injections, dry needling, or exercise

The comparative clinical efficacy of PRP, placebo (saline), autologous whole blood, and dry needling for ligament and tendon injury is unclear (Table 1). Lin *et al*[53] conducted a systematic review and meta-analysis of randomized controlled trials (RCTs) to investigate the effectiveness of PRP therapy in patients with RC tendinopathy compared to sham injection, no injection, or physical therapy alone. The study found that PRP therapy produced significant long-term pain relief (> 24 wk) but did not show significant differences in functional results compared to the control groups. Notably, the study included trials using various numbers of injections, ultrasound-guided and non-guided injection techniques, and different injection approaches, but it found no specific approach to be more effective than others.

Chen *et al*[26] conducted a systematic review and meta-analysis that evaluated the efficacy of PRP therapy in the healing of tendons and ligaments. The study analyzed 37 articles and included 1937 patients without restrictions on the tendons or ligaments studied. The authors found a wide variety of preparation methods used in the studies, and half of the studies did not use platelet activation or did not report the specific kit used. Despite this, the authors found no significant adverse events, highlighting the safety of PRP therapy. Overall, the PRP groups in the studies showed significantly less long-term pain than the control groups, particularly in lateral epicondylitis and RC injuries.

A randomized controlled study by Kesikburun *et al*[54] evaluated the effectiveness of PRP therapy in patients with RC tendinopathy who were treated with an exercise program. The study found that PRP was less effective than a placebo injection in several aspects, which can be attributed to leukocyte-rich PRP and shorter follow-up periods. However, another prospective open-label comparative trial compared a PRP group with an exercise group and found that PRP showed better American Shoulder and Elbow Surgeons Score (ASES) and Constant Murley Score (CMS) at 6 and 12 wk. However, at 24 wk, PRP was not superior to exercise. The PRP group had better rates of decreasing tendon thickness, but the concentration of leukocytes was not analyzed. Furthermore, the study found that higher levels of TGF-β1 and interleukin-1β growth factors were related to the clinical efficacy of PRP. This suggests that PRP provided more remarkable results than exercise alone, but exercise showed a cumulative positive effect in the long term, suggesting that more than a single injection may be necessary[55].

Wesner *et al*[56] reported results in a RCT that included 9 participants with RC tendinopathy receiving 4 mL of PRP injected into the supraspinatus or infraspinatus, and patients in the placebo group were injected with 4 mL of saline. All participants completed a 3-mo standardized home-based daily exercise program. The primary outcome measures were evaluated 3 and 6 mo after injection in RCT[56]. The study showed that patients who underwent PRP injections reported considerable improvements in pain and disability[56]. The authors concluded that intratendinous ultrasound-guided PRP

Table 1 Single or double-arms trials assessing effectiveness of platelet-rich plasma *vs* placebo injections, dry needling, or exercise

Ref.	Level of evidence	Design	Groups (*n*)	Injections/dosis	Outcomes measure	Follow-up	Conclusions
Kesikburun *et al*[54], 2013	I	Ultrasound-guided PRP injections *vs* saline injections	40 patients PRP (20), placebo (20)	1/5 mL	VAS, WORC, and SPADI	3, 6, 12, 24 wk. 1 yr	PRP is not more effective in improving shoulder quality of life, pain, disability, and range of motion than placebo
Rha *et al*[57], 2013	I	PRP injections *vs* dry needling	39 patients. PRP (20), dry needling (20)	1/3 mL	SPADI, passive ROM, global rating scale, ultrasound measurement	24 wk	PRP leads to a progressive reduction in pain and disability compared to dry needling
Scarpone *et al* [59], 2013	III	Ultrasound guided PRP injection at the lesion and surrounding tendon	18	1/3.5 mL	MRI, VAS and three-item patient satisfaction scale	8, 12, 52 wk	Improvement in MRI, pain and function with PRP
Lee *et al*[62], 2019	III	PRP injection *vs* exercise treatment; leukocyte-poor *vs* leukocyte-rich PRP	60. PRP (27), exercise (33)	1/1.5 mL	ASES, CMS, and NRS	12 wk, 24 wk	PRP is more effective than exercise therapy for the first 3 mo
Kim *et al*[55], 2019	II	PRP injection *vs* exercise treatment	30 patients. PRP (15), exercise (15)	1/2 mL	ASES, CMS, and NRS	12 wk, 24 wk	PRP had an advantage over exercise; improvement until 12 wk, slight decrease at 24 wk
Rossi *et al* [71], 2021	II	Subacromial PRP injections	50 patients	1/5 mL	ASES, CMS, and VAS	1 yr	PRP decreased pain, improved functional outcomes, and resolved sleep disturbances. Return to sports for most athletes
Oudelaar *et al* [77], 2021	I	NACD + PRP *vs* NACD + CI	88 patients. NACD + PRP (41), NACD + CI (47)	1/5 mL	VAS, CMS, DASH, OSS, EQ-5D	6 wk, 3 mo, 6 mo, 12 mo, 24 mo	NACD + PRP was worse at the 6-wk follow-up but better at the 6-mo follow-up. Comparable results at 12 and 24 mo

ASES: American Shoulder and Elbow Surgeons score; CMS: Constant Murley Score; CI: Corticosteroid injection; DASH: Disability of Arm-Hand-Shoulder score; PRP: Platelet-rich plasma; ROM: Range of motion; SPADI: Shoulder Pain and Disability Index; SST: Simple Shoulder Test; UCLA: University of California Los Angeles score; VAS: Visual analog scale; WORC: Western Ontario Rotator Cuff; MRI: Magnetic resonance imaging; NACD: Needle Aspiration of Calcific Deposits; OSS: Oxford Shoulder Score.

injection could improve tendon pathology as documented by magnetic resonance imaging (MRI). This finding provides information for future studies examining PRP effectiveness[56]. However, the study's limited sample size restricts the generalization of the results, and larger-scale studies are required to validate the findings.

A clinical trial compared the effectiveness of dry needling *vs* ultrasound-guided injection of PRP to treat RC tendinopathy[57]. The study found similar levels of effectiveness in reducing pain and improving function between dry needling and PRP injection. However, patients who received PRP injections experienced a steady decrease in pain and impairment six months after treatment, suggesting that PRP may have long-term benefits[57].

A recent systematic review and meta-analysis pooled the results of previous studies on the efficacy of PRP injections *vs* other treatments for patients with RC tendinopathy[58]. The study included 8 RCTs and found no significant differences between the PRP and control groups after three weeks of follow-up[58]. PRP was compared to saline injection in 4 trials, while rehabilitation programs and dry needling were control interventions in the other 4. PRP therapy's medium- and long-term outcomes were superior, except for the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. The most common adverse effect was mild and temporary pain[58].

In another long-term trial, 18 patients who had not responded to previous physical treatment but received a single 3.5 mL ultrasound-guided intralesional injection of PRP showed steady improvement on the Visual Analog Scale (VAS)[59]. At one year of follow-up, the median VAS dropped from 7.5 ± 0.3 before injection to 0.4 ± 0.2, and MRI alterations and functional outcomes similarly improved[59].

PRP vs corticosteroid injections

Subacromial corticosteroid injections (CI) or PRP have both seen an increase in comparative investigations in recent years [60-63] (Table 2). Some evidence supports that PRP could be a suitable substitute for patients who cannot use CIs, as suggested in a RCT of 40 patients with symptomatic partial-thickness RC tears, where PRP injections and CI were compared for pain control and patient-reported outcomes (PROs)[60]. Although both groups showed a significant improvement over the pre-injection condition at 12 wk, the PRP group showed a statistically significant improvement in pain and PROs at 24 wk. MRI at 6 mo of follow-up did not show significant differences between groups[60].

Table 2 Randomized controlled trials comparing platelet-rich plasma *vs* corticosteroid injections for rotator cuff tendinopathy

Ref.	Level of evidence	Design	Groups (*n*)	Dosis/quantity	Outcomes measure	Follow-up	Conclusions
Barreto *et al* [66], 2019	I	Subacromial PRP injections *vs* CI	51 patients. PRP (26), CI (25)	1/about 3 mL	DASH, UCLA-SRS, CMS	3mo, 6 mo	No statistically significant differences
Dadgostar *et al* [63], 2021	I	Ultrasound guided PRP injections *vs* CI	58 patients. (30) PRP, (28) CI	1/3 mL intra-articular, 3 mL intratendinoeus	VAS, ROM, WORC, DASH, US supraspinatus thickness	3 mo	PRP with similar results to CI
Kwong *et al* [70], 2021	I	Ultrasound-guided leokocyte-poor PRP injection *vs* CI	99 patients. PRP (47), CI (52)	1/(3-5) mL intratendineous (non-specific) and the rest at the subacromial space	VAS, ASES score, and WORC	6, 12, 48 wk	The PRP group showed superior improvement in pain and function at short-term follow-up, without benefit at long-term follow-up
Ibrahim *et al* [68], 2019	I	Ultrasound guided subacromial PRP *vs* CI	30 patients. PRP (15), CI (15)	1/2 mL	VAS, SDQ, ROM Clnical tests, US findings	8 wk	Both groups showed significant improvement. PRP is safe and can be used for PRCT
Jo *et al*[78], 2020	I	Ultrasound guided allogenic PRP *vs* CI	60 patients. PRP (30), CI (30)	1/4 mL	VAS, CMS, ASES, DASH, RC strength, ROM	1, 4, 12, 24 wk	PRP reduced pain and improved overall function at 6 mo. DASH score, overall function, and external rotation were significantly better in the PRP group
Pasin *et al*[79], 2019	I	PRP *vs* CI *vs* exercise	60 patients. PRP (30), CI (30)	1/4 mL	VAS, quick DASH, UCLA SRS, SF-36	3, 8 wk	PRP had better scores than CI and Physical Therapy even in a long time
Sabaah *et al* [80], 2020	I	Prolotherapy *vs* CI and PRP	40 patients. PRP (20), CI (20)	2/5 mL	VAS, WORC-Index, ROM and US findings	12 wk	Prolotherapy was superior. PRP improve tendon healing
Sari *et al*[81], 2020	I	Ultrasound guided PRP *vs* CI, prolotherapy and lidocaine	60 patients. PRP (30), CI (30)	1/5 mL	VAS, ASES and WORC	3, 12, 24 wk	CI were better at 3 wk. NO difference at 12 wk. PRP had better outcomes at 24 mo
Thepsoparn *et al*[82], 2021	I	Ultrasound guided leukocyte-poor PRP *vs* CI	31 patients. PRP (15), CI (16)	1/5 mL	VAS and OSS	4, 24 wk	No difference at 4 wk. PRP had better results at 24 wk for PRCT. No complications

ASES: American Shoulder and Elbow Surgeons score; CMS: Constant Murley Score; CI: Corticosteroid injection; DASH: Disabilities of the Arm, Shoulder and Hand score; PRP: Platelet-rich plasma; ROM: Range of motion; SPADI: Shoulder Pain and Disability Index; SST: Simple Shoulder Test; UCLA: University of California Los Angeles score; UCLA-SRS: University of California Los Angeles Shoulder Rating Score; VAS: Visual analog scale; WORC: Western Ontario Rotator Cuff; MRI: Magnetic resonance imaging; SDQ: Shoulder Disability Questionnaire; PRCT: Partial rotator cuff tears; SF-36: Short Form 36; OSS: Oxford Shoulder Score.

PRP has proven advantages, such as the possibility of repeat injections if symptoms worsen. It could even be administered 1 to 6 mo before surgery due to its safety, which contrasts with CI, and its recognized risk of perioperative complications[64,65]. However, the cost-effectiveness of PRP has not been established. Other reports have shown similar effectiveness between PRP and CI. In a randomized, double-blind trial, patients were evaluated using the DASH score, the University of California Los Angeles (UCLA) shoulder rating scale, and CMS at baseline and 1, 3, and 6 mo after treatment. Results showed no statistically significant differences ($P < 0.05$) between the PRP and CI groups in any outcome measures at any time. Both groups showed a significant improvement in DASH and UCLA scores ($P < 0.05$) compared to baseline, but the CMS score 6 mo after corticosteroid treatment was lower than baseline. These findings suggest that PRP is a safe treatment option for RC impingement syndrome and may be a valuable alternative, as it was found to be equally effective as corticosteroids[66]. Similar results were found in a prospective study with 60 patients with RC tendinosis or partial tendon tear. The authors used 2.5 mL of activated PRP or 40 mg methylprednisolone during the trial. The CMS improved from 41 to 53 points at 6 mo in the PRP group and from 38 to 66 points in the CI group[67].

In a study of 30 patients with RC tendinopathy, two groups of 15 were randomly chosen to receive a subacromial ultrasound-guided injection of PRP or corticosteroids. Pain in patients was evaluated using the VAS, shoulder function using the Shoulder Disability Questionnaire, and range of motion (ROM) before and 8 wk after injection. The study found that PRP and CI were similarly effective in the treatment of RC tendinopathy, showing significant improvements in pain, function, and ROM. These results suggest that PRP is a safe alternative to CI, decreasing inflammation and improving

outcomes[68].

In another double-blind clinical trial, 58 patients with RC tendinitis were randomized to receive 3 mL of PRP or 1 mL of Depo-medrol 40 mg. The study found that both treatments resulted in similar significant improvements in pain, ROM, Western Ontario Rotator Cuff scores, DASH scores, and supraspinatus thickness during follow-ups[63]. A recent systematic review and meta-analysis of RCTs that included 639 patients revealed that at short-term follow-up, CI was more effective than PRP in the short term, but, in the mid-term, PRP was superior to CI in DASH and ASES scores. However, both treatments achieved minimal clinical important difference for each score, indicating no significant clinical differences between the two treatment modalities in managing RC disease[69].

A double-blind, randomized controlled study compared ultrasound-guided PRP injection with conventional CI in patients who had completed a detailed physical therapy protocol. Ninety-nine patients with MRI or ultrasound documented partial-thickness RC tears or tendinopathy were included. Patients treated with leukocyte-poor PRP ultrasound-guided injections showed superior improvement in pain and function at short-term follow-up. However, at 12 mo, there was no persistent effect of PRP over CI and no variations in the incidence of failure or conversion to surgery [70]. Ultrasound-guided injection of PRP potentially improves the precision and safety of the infiltration method, thus leading to improved effectiveness of the treatment[3,68]. However, the benefit has not been demonstrated extensively.

In contrast, a recent systematic review and meta-analysis of 12 RCTs have shown that while CI may have better short-term outcomes in treating RC tendinopathy, PRP therapy may have superior medium-term outcomes. These results suggest that while CI may provide faster pain relief, PRP therapy may be more effective in promoting long-term healing and tissue regeneration[69]. However, it should be noted that the studies included in the review had significant heterogeneity in their preparation of PRP (such as using the buffy-coat method *vs* the tube method and using one *vs* two centrifugation steps) and their treatment protocols after injection[69].

Similarly, a prospective cohort study included 50 patients with MRI-diagnosed tendinopathy, no tendon rupture, and 3 mo of failed conservative treatment. Two spin protocols were performed, and 5 mL of leukocyte-rich PRP was used to treat patients in combination with physical therapy. Results included pain relief, positive clinical results, and a return to sports at the pre-injury level at high rates[71].

FUTURE PERSPECTIVE

Kieb *et al*[72] introduced an innovative method to standardize PRP growth factor concentrations using allogeneic lyophilized PRP powder. This technique involves creating a powder using twelve pooled platelet concentrations from various donors and comparing the growth factor concentration achieved using this technique to that found in whole blood. Theoretically, this approach allows the precise composition of the PRP to be chosen to provide a specific amount of growth factors based on the treated pathology. This advantage may provide a more controlled and efficient way to use the benefits of PRP therapy.

In a separate study, 17 patients with RC tendinopathy were treated with an injection of allogeneic PRP, while a control group received CI. Both groups experienced a significant reduction in pain and improved outcomes, with the CI group showing a faster recovery. No adverse effects were reported. The results of this trial suggest that allogeneic PRP may be a safe and potentially beneficial treatment option for RC tendinopathy, but further research is needed to confirm these findings and establish its long-term effectiveness[73].

High-quality evidence supports the use of PRP after RC repair[74]. However, the clinical evidence on the benefits of PRP in the nonoperative treatment of RC disorders is inconsistent. This makes it difficult to draw firm conclusions about PRP's advantages in treating RC disorders. Although some *in vitro* studies have shown promising results for PRP, clinical studies have not consistently supported its therapeutic impact.

Additionally, the effectiveness of PRP can depend on the type and concentration of the specific components used. Therefore, more research is needed to fully understand PRP's potential benefits and limitations in treating RC disorders. This situation highlights the need for a detailed investigation to define the optimal composition, efficient dose, and mechanism of action of PRP[73,75,76].

CONCLUSION

PRP therapy has been proposed as a treatment option for RC tendinopathy, but the available evidence is conflicting due to variability in settings, indications, and clinical outcomes. As a result, clinicians should approach PRP therapy with moderate and realistic expectations until more reliable evidence is available. While the basic science literature supports the potential of PRP to manage RC tendinopathy, there is not yet enough clinical data to support its effectiveness. However, PRP therapy is considered a safe treatment option because it uses a patient's blood, decreasing the risk of allergic reactions or other complications associated with the use of foreign substances. Therefore, it is reasonable to consider PRP injections in patients with a contraindication to CI or patients with risk factors for inadequate healing as a promising treatment option for RC tendinopathy.

FOOTNOTES

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