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The Efficacy of Platelet-rich Plasma in Arthroscopic Rotator Cuff Repairs: A Narrative Review

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Abstract

Rotator cuff tears are one of the most prevalent musculoskeletal disorders, with a significant risk of retear following repair. Platelet-rich plasma (PRP) has emerged as a potential adjunct to enhance healing through mechanisms including growth factor release, anti-inflammatory effects, and angiogenesis. This narrative review evaluates the efficacy of PRP augmentation in arthroscopic rotator cuff repairs by examining recent studies and meta-analyses. Findings indicate that PRP, particularly leukocyte-poor PRP, shows promise in improving pain and functional outcomes, and reducing retear rates, though its cost-effectiveness and optimal application protocols remain uncertain. Limitations of current studies and avenues for future research are also discussed.

Keywords: Platelet-rich plasma, Arthroscopic rotator Cuff repairs, Orthobiologics, PRP

Introduction

The burden of rotator cuff tears has increased over the years and has become the second most common musculoskeletal pathology after back pain which drives patients to seek treatment [1]. Despite the advent of new surgical techniques and devices, rotator cuff re-tears following arthroscopic rotator cuff repair, continues to pose a significant challenge [2]. The healing failure rates and re-tears have reported to range between 11% to 94% [3]. Surgical factors such as the size and retraction of the tear, the repair and fixation techniques used, the rehabilitation protocol, and importantly, the surgeon's experience, all influence the results of rotator cuff repairs. Besides that, patient factors like increasing age, quality of the cuff, comorbidities like diabetes and smoking, have an impact too [4]. At the level the problem lies in the fact that chronic degenerative tears have an inherent decreased microcirculation. When these tears are repaired, they heal by formation of a fibrovascular scar tissue at the tendon-bone interface which is a biomechanically inferior construct compared to the native cuff. This leads to rotator cuff re-tears and poor outcomes [5]. In the quest of improving healing rates, various biological factors like PRP, bone marrow concentrates, human acellular dermal patches and stem cells have been tried, out of which PRP has been the most widely used [5, 6, 7].

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What is PRP and its mechanism in rotator cuff healing

PRP is a platelet concentrate of autologous anticoagulated blood prepared by a double centrifugation technique [8]. It can be a leucocyte-rich prp or a platelet-rich prp based on the method of preparation [9].

After our thorough search we postulated the "4 As" with which PRP exerts its beneficial action on the cuff –

1) Alpha-granule degranulation
2) Anti-inflammatory
3) Analgesic
4) Angiogenesis

1) Alpha Granule Degranulation: PRP releases growth factors from alpha granules, including platelet-derived growth factor (PDGF) and transforming growth factor-beta (TGF-β), which increase collagen synthesis, improving tendon strength and promoting effective healing at the tendon-bone interface [6].

2) Anti-inflammatory: PRP reduces inflammatory cytokines such as IL-1β and TNF-α, potentially mitigating post-operative inflammation and reducing tendon degradation [6].

3) Analgesia: Through the release of protease-activated receptor 4 peptides, PRP provides an analgesic effect, which may improve post-operative recovery by reducing pain [10].

4) Angiogenesis: PRP promotes angiogenesis by releasing vascular endothelial growth factor (VEGF) and other factors that enhance blood vessel formation, facilitating nutrient-rich blood flow to the tendon-bone interface [9].

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Types of PRP and Their Effects

Two primary types of PRP are commonly studied:

• Leukocyte-Rich PRP (L-PRP): This form includes a higher leukocyte concentration, which can increase inflammation and catabolic signaling, potentially hampering healing [11].

• Platelet-Rich PRP (P-PRP): With fewer leukocytes, P-PRP provides a more anabolic environment, which is beneficial for tissue healing by minimizing inflammatory mediators [11].

Methodology

A literature search was performed using electronic data bases like Medline, EMBASE and Google scholar. Papers containing the key terms "platelet-rich plasma" or "PRP" AND "arthroscopic rotator cuff repairs". Full-length, English language articles were screened for including from January 2014 to October 2024. Randomised controlled trials, systematic reviews and metanalysis comparing the combination of rotator cuff repairs with PRP to arthroscopic rotator cuff repairs alone, were included. We included all articles which had an arthroscopic rotator cuff repair done for full thickness tears. The group with PRP augmentation had a time period between administration of PRP and surgery, not longer than a month. Single-row as well as double-row repair techniques were included. The studies included had a follow-up of more than 2 months. Studies having a previous surgery on the same shoulder, shoulder arthritis, and associated fractures, dislocations or infections, were excluded.

In this review, we categorized the findings based on key aspects of PRP efficacy, including clinical and functional outcomes, the timing of PRP administration, cost-effectiveness, and optimal concentration.

Pre-op patient selection:

Inclusion Criteria:

• Patients with complete supraspinatus tears.

• Tears confirmed by magnetic resonance imaging (MRI).

• No history of trauma associated with the tear.

• Retraction of less than 3 cm.

Exclusion Criteria:

• Tears involving other tendons (e.g., infraspinatus or subscapularis).

• Fatty degeneration of the muscle, classified as grade 3 on the Fuchs scale.

• Presence of glenohumeral arthrosis.

• History of previous shoulder surgery.

• Co-existing psychiatric or rheumatological diseases.

• Diagnosis of fibromyalgia.

• Spinal conditions affecting shoulder function.

• Platelet count below 150,000/mm^3.

• Intraoperative findings of subscapular tears requiring repair, infraspinatus tears, irreparable tears, or conversion to open surgery.

Outcomes of PRP administration:

Earlier randomised controlled trials did not show any benefit of PRP augmentation in cuff repairs as compared to isolated rotator cuff repairs [12, 13]. However, early meta-analysis Cai et al and Han et al, showed significant benefits with the PRP augmentation group. The largest meta-analysis by Trantos et al, showed improved pain outcomes, functional scores and reduced retear rates with PRP augmentation [14]. There was a discrepancy in the outcomes between the early and recent studies between the two groups. The rationale for this was given by Ahmed et al, where they stated that the earlier studies had less number of patients and were inadequately statistically powered to show a significant difference in favour of the PRP group [2].

The meta-analysis by Ryan et al, which included cuff repairs for full thickness tears, showed superior outcomes with P-PRP as compared to L-PRP [15]. A very recent study by Rossi et al confirm these findings, suggesting P-PRP's advantages in enhancing tendon quality and reducing post-operative pain [16].

An additional, though often underestimated, factor is the timing of the PRP injection along with the number of doses. The hematoma generated during an arthroscopic cuff repair has a lot of healing potential along with growth factors. Adding a PRP injection at that same time can have two potential shortcomings. It can cause excessive growth factors leading to a net dilution effect due to receptor overloading, and the PRP injected can be subjected to a washout effect pertaining to the use of saline during the arthroscopy. Furthermore, giving a PRP injection 7 to 14 days after the repair can have the added advantage of a sustained release of growth factors [5, 17].This hypothesis was given by Wang et al in his study, but interestingly the outcomes of his study, showed otherwise. In their study, half of the patient cohort received two PRP applications—one at 7 days and another at 14 days postoperatively. At the final 16-week follow-up, there were no clinical or radiological differences observed between the two groups [17]. A study by Liu et al compared two groups which underwent arthroscopic rotator cuff repairs. One group received PRP injection during the repair and the other group received a PRP injection during the repair as well as a booster dose after 7 days. Outcomes showed no significant clinical benefit with the booster dose group.

Vavken et al and Samuelson et al conducted a study to determine if PRP augmentation with arthroscopic cuff repairs are cost effective considering all factors. They concluded that there was a definitely a reduction in retear rates in small to moderate sized tears, but PRP augmentation as of today is currently not cost effective [18, 19].

Nunes et al, in his study has evaluated whether PRP cell concentration has an effect on rotator cuff healing when augmented with an arthroscopic cuff repair. It is the only study which evaluates the above mentioned, and it shows that a concentration close to the target of 106 per microlitre improves healing and functional outcomes [19].

With perspective to the Indian scenario, a randomised controlled trial was done by Pandey et al where they augmented PRP with single row rotator cuff repairs for full thickness tears and compared it with isolated rotator cuff repairs. They found that PRP augmentation led to reduced re-tear rates and superior structural outcomes. They also found that PRP improved the vascularity of the rotator cuff tendon in the early phase of healing, however found no difference between moderate and high concentration PRP preparations [20].

Follow-Up Results in a nutshell:

1. Pain and Functional Outcomes:

• Meta-analyses, such as those by Trantos et al. and Ryan et al., report significant improvements in pain relief and functional scores with PRP augmentation.

• Studies show better outcomes with leukocyte-poor PRP (P-PRP) compared to leukocyte-rich PRP (L-PRP), emphasizing the importance of preparation.

2. Retear Rates:

• PRP reduces retear rates, particularly in small to medium-sized tears, with significant structural improvements noted in these cohorts.

3. Timing and Dose Effects:

• Studies investigating delayed PRP injections (7–14 days post-surgery) show no additional clinical benefit over intraoperative administration.

• Higher platelet concentrations close to a target of $10^6/\mu L$ are associated with better healing.

4. Indian Study Insights:

• A randomized controlled trial by Pandey et al. highlighted reduced retear rates and superior structural outcomes with moderately concentrated PRP in single-row rotator cuff repairs.

5. Cost-Benefit Considerations:

• Although PRP demonstrates clinical benefits, its high cost limits its routine application in practice, making it selectively applicable for certain cases.

Pros and Cons of using PRP in rotator cuff tears:

(Table 1)

Limitations and Future Directions

Variations in preparation protocols, including platelet concentration and leukocyte content, make direct comparison challenging. Standardized preparation guidelines are necessary to improve comparability across studies. Secondly, differences in patient demographics, comorbidities, and tear characteristics affect outcomes, creating variability in findings. Future studies should aim to stratify results based on these factors. Furthermore, considering PRP is made from autologous blood, each PRP will have a different concentration of growth factors, which might again confound the outcomes.

Studies do provide follow-up beyond two years, but studies having the ability to assess long-term benefits and retear rates would be more beneficial. Longer follow-ups are needed to clarify PRP's potential as a sustainable solution.

Future directions should focus on larger, multi-center RCTs that utilize standardized PRP preparation protocols, ideally with sub-group analyses to determine which patient demographics and tear characteristics benefit most from PRP. This will also help us determine the role of PRP in clinical practice today with defined indications for the same.

Conclusion

As of today, the efficacy of PRP in arthroscopic rotator cuff repairs is not absolutely conclusive, however recent studies do show it to be a promising adjunct to rotator cuff repairs with respect to better pain outcomes, functional outcomes and reduced retear rates. Giving a delayed PRP injection post rotator cuff repair has a theoretical rationale, but studies prove otherwise and show no significant benefit with the same. PRP holds promise as an adjunct to rotator cuff repair, particularly in reducing retear rates in small to moderate tears, but is not cost effective as of today, according to the existing literature. Inconsistencies in clinical and functional results necessitate more research with emphasis on Indian studies to establish clear, evidence-based guidelines. Until further evidence is available, PRP should be considered selectively, with future studies focused on identifying specific patient and tear characteristics that would most benefit from PRP augmentation.

Table 1: Pros and Cons of using PRP in Rotatory Cuff Tears

Pros	Cons
Improved Pain Outcomes: PRP provides analgesic effects by releasing protease-activated receptor 4 peptides, reducing pain postoperatively	**Cost-Effectiveness:** PRP augmentation is currently not considered cost-effective for small to moderate tears in India
Enhanced Healing: Growth factors like PDGF and TGF-β promote collagen synthesis, aiding tendon-bone interface healing	**Variability in Results:** Differences in preparation protocols (e.g., platelet concentration) lead to inconsistent outcomes
Reduced Retear Rates: Studies show a reduction in retear rates, especially in small to medium-sized tears	**Lack of Standardization:** Variation in preparation and administration techniques affects comparability
Anti-inflammatory Effects: PRP reduces pro-inflammatory cytokines (IL-1β, TNF-α), mitigating post-surgical inflammation	**Potential Overdose Effect:** Concurrent PRP injections during surgery may lead to receptor overloading or washout effects
Angiogenesis Promotion: PRP stimulates VEGF release, improving vascularity and nutrient flow to the repair site	**Uncertain Long-Term Benefits:** Current studies provide limited data on long-term outcomes

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

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