
ORIGINAL ARTICLE**Functional and radiological outcomes following ultrasound-guided platelet-rich plasma injection in partial thickness supraspinatus tears: A prospective study***M.L.S.V. Prasad¹, Sheshagiri V¹, Srinivas Hebhal Thammaiah¹, B. Gurumurthy¹, Vidya CS^{2*}**¹Department of Orthopaedics, ²Department of Anatomy JSS Medical College, JSS AHER Mysuru-570015, (Karnataka) India*

Abstract

Background: Partial thickness supraspinatus tears are a common cause of shoulder pain and functional limitation, particularly in the middle-aged population. Platelet-Rich Plasma (PRP), an autologous concentrate rich in growth factors, has emerged as a potential biological therapy aimed at enhancing tissue regeneration. **Aim and Objectives:** To evaluate the functional and radiological outcomes of ultrasound-guided PRP injection in partial-thickness supraspinatus tears. **Material and Methods:** A prospective observational study was conducted on 50 patients (aged 40–70 years) with partial-thickness supraspinatus tears. All participants received a single ultrasound-guided leukocyte-poor PRP injection followed by standardized rehabilitation. The Visual Analogue Scale (VAS), Constant Shoulder Score, and Shoulder Pain and Disability Index (SPADI) were evaluated at baseline, 3, 6, and 9 weeks. Ultrasonography was used to measure tear extent, tendon thickness, and tendon width. Data were analysed using repeated-measures ANOVA. **Results:** Statistically significant improvements were observed across all parameters ($p < 0.001$). Mean VAS decreased from 7.68 ± 0.82 to 2.66 ± 0.61 , constant score improved from 43.50 ± 5.12 to 79.56 ± 4.28 , and SPADI score decreased from 70.98 ± 6.44 to 24.12 ± 4.80 . Sonographically, tear extent reduced from 6.48 mm to 3.94 mm, tendon thickness increased from 5.10 mm to 6.22 mm, and tendon width increased from 13.10 mm to 14.90 mm. **Conclusion:** Ultrasound-guided PRP injection yields significant clinical pain relief, functional restoration, and quantitative ultrasonographic structural healing in partial-thickness supraspinatus tears.

Keywords: Rotator cuff injuries, Ultrasonography, Platelet-rich plasma, Treatment outcome

Introduction

Rotator cuff diseases are one of the most common causes of shoulder pain and dysfunction, particularly among the middle-aged and elderly population [1]. The supraspinatus tendon is most commonly affected because of its anatomical position and its susceptibility to repetitive mechanical stress and degenerative changes [1]. Partial-thickness tears of the supraspinatus tendon are considered an early stage of rotator cuff disease and are often associated with pain, weakness, and limited shoulder movements, with the potential to progress to full-thickness tears if left untreated [1]. The common treatments such as physiotherapy, non-steroidal

anti-inflammatory drugs and corticosteroid injections mainly alleviate symptoms but do not treat the underlying tendon degeneration [2]. Furthermore, repeated injections of corticosteroids can have a deleterious effect on tendon integrity and delay the healing process [2]. These limitations have prompted increased interest in biological treatment modalities, which seek to stimulate tendon healing rather than just offer symptom relief. Platelet-Rich Plasma (PRP) is a promising biological therapy because it contains high concentrations of growth factors that are important for tissue repair and regeneration [2,3]. These growth factors promote

collagen synthesis, angiogenesis and cellular proliferation and thus help in healing of the tendon [3].

The effectiveness of PRP in rotator cuff pathology has been shown in several clinical studies. PRP injection was associated with a significant reduction in pain [4]. Niazi *et al.* (2020) observed an improvement in clinical outcomes and in ultrasound-guided PRP tendon thickness [5]. Sengodan *et al.* (2017) reported better functional outcomes in patients with partial thickness rotator cuff tears treated with PRP [6]. Tahirian & Moezi (2016) showed improvement in tendon morphology after PRP therapy [7] and Prodromos *et al.* (2021) reported sustained clinical and structural improvement at follow-up [8]. Kesikburun *et al.* (2013) further supported the role of PRP in improving functional outcomes in rotator cuff tendinopathy in a randomized controlled trial [9].

Despite these encouraging findings, the literature to date has a number of limitations. Most of the previous studies have focused on clinical outcomes such as pain relief and functional improvement but have not provided objective and quantitative radiological evidence of tendon healing [4-6]. In those studies that have used imaging, there has been a lack of standardization in the assessment of tear dimensions and a poor correlation between radiological findings and clinical outcomes [7,8]. In addition, systematic reviews and meta-analyses have reported variability in results due to differences in PRP preparation techniques and the lack of uniform protocols [10,11].

PRP has been evaluated in randomized and comparative studies for rotator cuff disorders; however, many of these studies have evaluated postoperative augmentation or compared PRP to other treatment modalities rather than its role in the primary

management of partial-thickness tears with detailed structural assessment [12-14]. The standard orthopedic literature stresses the importance of biological healing in tendon pathology but does not offer a quantitative imaging-based evaluation in routine clinical setting [15].

Thus, there is a scarcity of literature on comprehensive studies assessing both clinical and radiological outcomes using objective and reproducible measurement parameters. The current study aimed to bridge this gap by evaluating the effectiveness of PRP in partial-thickness supraspinatus tears by a combination of clinical scores and quantitative ultrasonographic parameters such as the extent of the tear, the thickness of the tendon and the width of the tendon at serial follow-up. This study offers a more complete assessment of PRP therapy than prior studies by demonstrating both symptomatic improvement and objective structural healing. The present study was specifically focused on supraspinatus tendon tears, which were the most common rotator cuff tear. The use of advanced imaging modalities has greatly improved the diagnostic arena of shoulder pathology allowing for precise mapping of rotator cuff tears and acromial morphology [16,17]. Numerous magnetic resonance imaging (MRI) studies have highlighted the need for detailed anatomical and morphological evaluation, particularly in the differentiation of tendon disruption from adjacent osseous variations [16,17]. The combination of objective and quantitative imaging markers, in addition to clinical pain and disability parameters, provides a powerful basis to monitor non-surgical tissue healing over time [16].

Material and Methods

Study design and setting: This prospective observational study was conducted at JSS Medical College and Hospital, Mysuru, after obtaining approval from the Institutional Ethics Committee

(IEC Ref No: JSS/MC/PG/2824/2023-24, dated 12-03-2024).

Study duration: The study was conducted from 18/5/2024 to 13/1/2026.

Study population: Patients aged between 40 to 70 years presenting with shoulder pain for more than three months and having a clinically and ultrasonographically confirmed partial-thickness supraspinatus tendon tear were included in the study. Written informed consent was obtained from all participants prior to enrolment. Patients with full-thickness rotator cuff tears, traumatic or sports-related supraspinatus tendon tears, previous shoulder surgery, inflammatory arthropathies, coagulopathy or bleeding disorders, infection at the injection site, or a history of corticosteroid injection within the preceding three months were excluded from the study.

Measures taken to address bias: Selection bias was prevented through the use of explicit inclusion and exclusion criteria allowing the creation of a relatively homogeneous group of study subjects and reducing the impact of various independent determinants on clinical and radiographic outcomes.

Data or information bias was prevented by using a standard set of instruments for clinical evaluations, including the Visual Analogue Scale (VAS), Constant score, and Shoulder Pain and Disability Index (SPADI). Radiographic parameters were evaluated in accordance with a predetermined schedule of evaluation procedures. All study subjects were prospectively followed up at baseline and after 3, 6, and 9 weeks.

Sample size: For this study, the sample size was estimated using the formula for a single proportion: At a 3.3% prevalence rate of degenerative rotator cuff tears, the probability Proportion (P) was

taken to be 0.033, with $Q = 1 - P = 0.967$. At a 95% confidence level ($Z = 1.96$), and with absolute precision (d) of 5% (0.05), the required sample size turned out to be 49, but the 50 participants were included.

$$n = \frac{Z^2 PQ}{d^2}$$

PRP preparation: PRP was prepared under strict aseptic conditions using a standardized double-spin centrifugation technique. Approximately 20 ml of autologous venous blood was drawn from the antecubital vein using an 18–20 G needle and collected into acid Citrate Dextrose (ACD-A) anticoagulant tubes to prevent premature platelet activation. The collected blood underwent a first (soft) centrifugation at 2000 rpm for 10 minutes, which separated the sample into three layers: Bottom layer: Red Blood Cells (RBCs); middle buffy coat containing platelets and leukocytes; upper plasma layer. The plasma and buffy coat were carefully aspirated into a sterile tube without disturbing the RBC layer.

A second (hard) centrifugation was then performed at 3000 rpm for 10 minutes. After centrifugation, the upper two-thirds (platelet-poor plasma) was discarded. The lower one-third containing concentrated platelets with a small amount of superficial buffy coat was retained and gently mixed to obtain approximately 2–3 mL of leukocyte-poor Platelet-Rich Plasma (LP-PRP). The PRP was prepared immediately before administration and injected within 30 minutes of preparation to preserve platelet viability. No exogenous platelet activator was used before injection.

Injection technique: The prepared PRP was injected under ultrasound guidance using a 22–25-gauge needle directly into the site of the supraspinatus

tendon tear with the patient positioned in the Modified Crass position. Approximately 2–3 ml of PRP was injected at the site of pathology. The PRP used in this study was leukocyte-poor PRP, aiming to reduce inflammatory response and enhance tendon healing.

Post-injection rehabilitation protocol: Following the procedure, patients were advised relative rest for 48 hours. Passive range-of-motion exercises were initiated thereafter, followed by gradual progression to active movements. Strengthening exercises were introduced after pain reduction. Non-steroidal anti-inflammatory drugs were avoided to prevent interference with the biological activity of PRP.

Outcome measures: Clinical evaluation was performed using the VAS for pain assessment, Constant Shoulder Score for functional evaluation, and SPADI for disability assessment. Radiological assessment included measurement of tear extent, tendon thickness, and tendon width using ultrasound examination. All parameters were recorded at baseline (pre-injection) and during follow-up at 3 weeks, 6 weeks, and 9 weeks.

Statistical analysis

Data were collected, and analysed using the Statistical Package for the Social Sciences software version 26.0. Descriptive statistics were obtained for the participants' demographic and clinical characteristics. Categorical variables such as sex, affected side and location of the tear were presented as frequency and percentage, respectively. Continuous variables were expressed as mean and Standard Deviation (SD).

Repeated-measures analysis of variance (ANOVA) were used to compare the changes in tear extent, tendon width, tendon thickness, VAS score, Constant score, and SPADI score between baseline and 3,

6, and 9 weeks. The sphericity assumption was checked using Mauchly's test and the Greenhouse-Geisser correction was used when needed. Post hoc comparisons at each time point were done using the Bonferroni test.

A mixed ANOVA was conducted to examine changes over time by sex, side affected, and location of the tear. Pearson and partial correlation analyses were performed to assess the association of age, radiological findings, pain and functional outcomes. Statistical significance was defined as a $p < 0.05$.

Results

Baseline characteristics

Fifty patients with symptomatic partial-thickness supraspinatus tendon tears were enrolled in the present study. All patients underwent the planned follow-up assessments. Table 1 displays the demographic and baseline clinical characteristics of the study population. Clinical and radiological parameters were used to evaluate the results at baseline and at follow-up time points of 3, 6, and 9 weeks after PRP injection.

Clinical results

Pain intensity and functional status were evaluated by VAS, Constant Shoulder Score and SPADI. Mean VAS scores decreased from 7.68 at baseline to 2.66 at 9 weeks as pain progressively improved. Functional assessment showed significantly better results with the Constant Shoulder Score increasing from 43.50 to 79.56. Similarly, a substantial reduction in pain and disability was seen, with the SPADI scores dropping significantly from 70.98 to 24.12.

Radiological findings

Ultrasound evaluation showed progressive structural changes in the supraspinatus tendon. The mean tear

length decreased from 6.48 mm at baseline to 3.94 mm at final follow-up. At the same time tendon thickness increased from 5.10 mm to 6.22 mm and tendon width increased from 13.10 mm to 14.90 mm. Tendon echotexture was also improved with reduction in hypoechoic areas indicating ongoing tendon healing.

Overall results

A consistent improvement was observed in all clinical and radiological parameters at each subsequent follow-up visit indicating a favourable therapeutic response to PRP. The observed changes were statistically significant ($p < 0.001$) and supported the efficacy of PRP to improve functional

recovery and tendon healing. Table 2 shows the clinical and radiological results.

Correlation

Pearson correlation analysis demonstrated that reduction in tear extent significantly correlated with decreased VAS pain scores ($r = 0.684, p < 0.001$), increased constant shoulder scores ($r = -0.712, p < 0.001$), and decreased SPADI disability scores ($r = 0.658, p < 0.001$). Increased tendon thickness also positively correlated with Constant scores ($r = 0.589, p < 0.001$). Partial correlation controlling for age, sex, and tear location confirmed these structural-functional relationships remained statistically significant ($p < 0.001$).

Table 1: Demographic Profile (n = 50)

Category	Sub category	Number (Percentage)
Age Group	45-52 years	17 (34%)
	53-58 years	21 (42%)
	59-65 years	12 (24%)
Sex	Female	26 (52%)
	Male	24 (48%)
Side	Right	41 (82%)
	Left	9 (18%)

Table 2: Comparison of clinical and radiological outcomes over time (n = 50)

Parameter	Baseline (Pre)	3 Weeks	6 Weeks	9 Weeks	F	p	Effect size (η^2)
Radiological parameters							
Tear Extent (mm)	6.48 ± 0.74	5.76 ± 0.68	4.82 ± 0.61	3.94 ± 0.52	184.32	<0.001	0.790

Continued...

Tendon Width (mm)	13.10 ± 1.12	13.82 ± 1.05	14.42 ± 0.98	14.90 ± 0.89	112.45	<0.001	0.697
Tendon Thickness (mm)	5.10 ± 0.48	5.48 ± 0.44	5.96 ± 0.41	6.22 ± 0.38	95.18	<0.001	0.660
Clinical parameters							
VAS Score	7.68 ± 0.82	5.68 ± 0.74	3.68 ± 0.65	2.66 ± 0.61	426.15	<0.001	0.897
Constant Score	43.50 ± 5.12	56.58 ± 4.88	68.62 ± 4.54	79.56 ± 4.28	682.40	<0.001	0.933
SPADI Score	70.98 ± 6.44	55.84 ± 5.82	38.54 ± 5.14	24.12 ± 4.80	512.90	<0.001	0.913

Discussion

Rotator cuff disease, especially of the supraspinatus tendon, is a frequent source of shoulder pain and functional limitation in the adult population [1]. The pathology is often degenerative leading to partial thickness tears that may progress if not treated appropriately [1]. Symptomatic relief is achieved with conventional treatment modalities, but the underlying tendon pathology is not addressed, thus necessitating the development of biological treatment strategies [2-3]. The therapeutic effect of PRP is achieved through release of growth factors, including Platelet-Derived Growth Factor (PDGF), Transforming Growth Factor-beta (TGF-β) and Vascular Endothelial Growth Factor (VEGF), which stimulate tenocyte proliferation, collagen synthesis and angiogenesis and thus help tendon healing.

The effectiveness of PRP in rotator cuff pathology has been shown in several clinical studies [4-9]. Despite these encouraging results, there are several limitations in the present literature [4-6,7,8,10-15]. The present study was done to evaluate the clinical and radiological outcomes. Pain (VAS), functional

outcomes (Constant Shoulder Score and SPADI) and ultrasonographic parameters had significant improvement. Radiological evaluation showed a decrease in the extent of the tear with an increase in tendon thickness and width indicating structural healing (Figure 1).

The quantitative measurement of the dimensions of the tear, ranging from 0.44 cm to 0.72 cm, was an important finding of the present study. This variation reflects the spectrum of partial-thickness supraspinatus tears and underscores the utility of ultrasound in providing accurate and reproducible measurements. Unlike previous studies that primarily focused on clinical outcomes, this study provides evidence for a direct relationship between smaller tear size and better functional scores.

The biological basis of PRP therapy is the release of growth factors that stimulate fibroblast proliferation and collagen synthesis, thus promoting tendon regeneration and restoration of normal tendon architecture [2,3]. This regenerative effect explains the persistent improvement in both clinical and

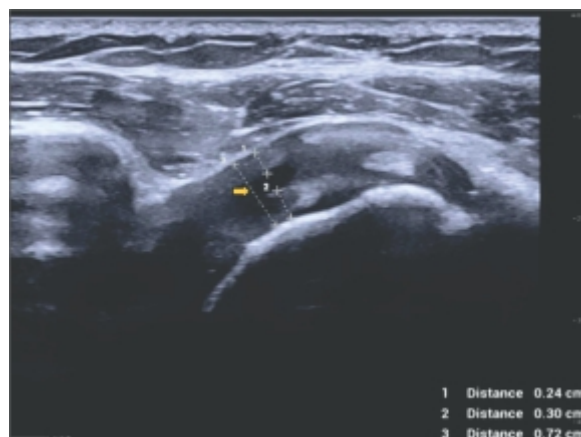


Figure 1(a):Pre-PRP image showing a focal hypoechoic defect measuring approximately 0.72 cm in mediolateral extent with depth of 0.24–0.30 cm, consistent with a partial-thickness tear. The arrow shows the hypoechoic defect representing the tear.

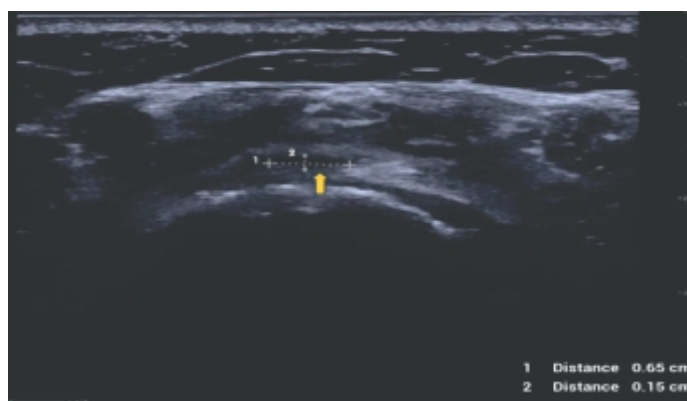


Figure 1(b):Follow-up image demonstrating reduction in the size of the hypoechoic defect with improvement in tendon echotexture. The arrow shows the reduced tear area



Figure 1(c):Final follow-up image showing marked reduction in tear extent with near restoration of normal fibrillar pattern. The arrow shows near-complete resolution of the tear.

radiological parameters. Thus, the present study adds to the literature by providing objective evidence of tendon healing with quantitative ultrasonographic assessment as well as clinical improvement. The combined assessment supports PRP as an effective treatment for partial thickness supraspinatus tears.

The improvements in VAS and Constant Shoulder Score were beyond the Minimal Clinically Important Difference (MCID), demonstrating statistically significant and clinically relevant changes. Unlike corticosteroid injections that may inhibit tendon healing, PRP creates a biologic environment favorable to tissue regeneration. Assessment of shoulder pathology remains critical in the evaluation of the effectiveness of biological interventions. MRI studies on shoulder pain and rotator cuff tears have shown a strong correlation between morphological variations (e.g. acromial architecture) and the degree of tendon degeneration [16, 17]. MRI provides detailed multiplanar view of acromial variations and deep soft tissue changes [16, 17]. However, high-resolution ultrasonography provides dynamic real-time evaluation of soft-tissue healing and tendon thickness without radiation and high cost. Quantitative imaging that indicates structural improvement is consistent with the broader radiological findings in rotator cuff pathology, where biological repair on serial imaging correlates directly with functional recovery [16].

Strength of the study

It was an observational prospective study with the pre-established inclusion and exclusion criteria for the selection of the patients and their follow-up. Serial clinical and radiological outcomes were assessed for a comprehensive evaluation of the

efficacy of treatment. Objective ultrasonographic parameters such as extent of tear, tendon thickness and tendon width were also evaluated at regular intervals apart from validated clinical outcome measures such as VAS, Constant Shoulder Score and SPADI. This combined assessment allowed for correlation of symptomatic improvement with structural healing of the tendons. All the PRP injections were also performed under ultrasound guidance which enabled precise injection of the injectate to the pathology site and improved the consistency of the procedure. The study also provided quantitative ultrasonographic evidence of tendon healing, a parameter that has been inadequately addressed in many previous studies evaluating PRP therapy for rotator cuff disorders.

Limitations

The present study has some limitations. The sample size was relatively small and may limit the generalizability of the findings. However, the follow-up period was limited to 9 weeks and thus does not represent long term results of PRP therapy. The lack of a control group or comparative arm (e.g. corticosteroid injection or physiotherapy alone) limits direct comparison of treatment efficacy. Reproducibility of results might be influenced by variability in PRP preparation techniques and the lack of standardization in platelet concentration. Ultrasound is reliable and inexpensive, but is operator dependent and may lead to variability in measurements.

Clinical implications

The results of this study suggest that ultrasound-guided PRP injection may be a useful minimally invasive treatment method for patients with partial thickness supraspinatus tears. Significant improvement in pain, shoulder function, scores of disability

and ultrasonographic tendon healing from baseline to follow-up period was observed. PRP may help to reduce symptoms, functional outcome and possibly delay or obviate the need for surgical intervention in appropriately selected patients. Ultrasound guidance enables accurate delivery of PRP to the site of pathology and enhances treatment accuracy and reproducibility in routine clinical practice.

Conclusion

Ultrasound-guided injection of PRP was associated with significant improvement in pain, shoulder function, disability and ultrasonographic measures of tendon healing in patients with partial-thickness

tears of the supraspinatus. In appropriately selected patients, PRP may be a useful nonsurgical treatment option. Bigger studies and longer follow-up are required to confirm its long-term effectiveness and to optimize treatment protocols.

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***Author for Correspondence:**

Dr. Vidya CS, Department of Anatomy, JSS Medical College, JSS Academy of Higher Education & Research Sri Shivarathreeswara Nagar Mysuru-15
Email: vidyacs@jssuni.edu.in Cell: 9449679386

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