

Does Intraoperative Platelet-rich Plasma Improve Clinical and Structural Outcomes after Arthroscopic Repair of Isolated Tears of the Supraspinatus Tendon?

Abstract

Background: Arthroscopic cuff repair is a highly successful technique, but postoperative rehabilitation is complex and the rate of tear recurrence is not negligible. Biological augmentations have been proposed to overcome these drawbacks. The platelet-rich plasma (PRP) is a platelet-rich blood fraction that is applied on the repair site to enhance tendon healing. This study evaluates the effectiveness of PRP application in arthroscopic cuff repair. **Materials and Methods:** A prospective nonrandomized study was carried out on 22 patients undergoing arthroscopic rotator cuff repair. Only patients with isolated and repairable supraspinatus tears were included and divided into two groups: 11 patients (Group A) received intraoperative PRP and 11 patients (Group B) did not. All patients had the same rehabilitation and followup protocol. Clinical–functional parameters (visual analog score, active range of motion, University of California at Los Angeles - UCLA, Constant) were recorded at predefined intervals, and magnetic resonance imaging (MRI) was performed 1 year postoperative. **Results:** Only one patient of Group B did not complete the study protocol. No intraoperative or postoperative complications were observed. No differences were found in the clinical–functional parameters during the entire study. At 1 year, MRI showed 1 retear in Group A and 2 retears in Group B, but the difference was not significant. **Conclusions:** The role of PRP as an adjuvant for surgical repair of rotator cuff tears is controversial. In this study, we could not demonstrate significant advantages of PRP for arthroscopic repair of isolated supraspinatus tears. The potential improvement in the structural outcome should be evaluated in the long term to justify the additional costs related to PRP application.

Keywords: Arthroscopic rotator cuff repair, platelet-rich plasma, rotator cuff tear

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Introduction

Rotator cuff disease is the most common cause of shoulder pain and functional impairment in middle-aged and elderly people. The incidence and size of rotator cuff tears increase with age, but clinical symptoms are quite variable and not necessarily related to the severity of the anatomical damage.^{1,2}

The therapeutic options are numerous, ranging from conservative treatment to reverse shoulder arthroplasty, and a careful evaluation of every patient should be carried out before decision-making.

Arthroscopy has greatly improved the surgical approach to rotator cuff tears, and arthroscopic repair is now performed by the majority of shoulder surgeons.^{3,4} Even though this procedure is highly effective,

concerns still exist about the demanding postoperative rehabilitation and the risk of tear recurrence. For these reasons, new biological strategies have been proposed to overcome these drawbacks.

Platelet-rich plasma (PRP) is an autologous blood fraction containing concentrations of platelets above baseline values and rich in several growth factors and cytokines, which play key roles in hemostasis, revascularization, and tissue repair.^{5,6} During the last years, several authors have reported their clinical experiences with PRP application in rotator cuff repair. Results have been controversial, and this discrepancy might also be related to different anatomical and clinical conditions of the treated patients.^{7,8}

This study evaluates the effectiveness of PRP by comparing the clinical and structural short term results between

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two homogeneous groups of patients, who underwent arthroscopic repair of isolated supraspinatus tendon tears with or without PRP addition.

Materials and Methods

A prospective nonrandomized study was carried out on 22 patients undergoing arthroscopic rotator cuff repair at a single institution. The inclusion criteria were as follows: age ranging from 30 to 65 years, shoulder pain and/or functional impairment caused by an isolated and repairable supraspinatus tear, Stages 1–2, according to Patte classification (Stage 1 – proximal stump close to bony insertion; Stage 2 – proximal stump at level of humeral head; Stage 3 – proximal stump at glenoid level),⁹ without atrophy or fatty infiltration of the muscle, Stages 0–1 of the Goutallier–Fuchs classification (Stage 0 – normal muscle; Stage 1 – some fatty streaks; Stage 2 – <50% fatty muscle atrophy; Stage 3 – 50% fatty muscle atrophy; Stage 4 – >50% fatty muscle atrophy).^{10,11}

Patients with different tendon tears, previous surgical repairs or steroid injections, joint stiffness, instability, degenerative joint changes, rheumatoid arthritis, or infections were excluded.

Demographic data of the patients are reported in Table 1.

The study protocol was approved by the local institutional review board; all patients signed informed consent reporting the purpose and the procedures related to the study.

Before inclusion in the study, every patient was thoroughly evaluated by clinical examination (visual analog score [VAS], active forward elevation, Constant,¹² and UCLA¹³ scores). There were no significant differences in the preoperative clinical characteristics between the two groups [Table 2].

Magnetic resonance imaging (MRI) was performed according to a protocol designed to optimally assess rotator cuff tears and muscle conditions; the images were evaluated blindly by an expert radiologist. The retraction of the supraspinatus tendon, according to Patte classification, was equivalent in the 11 shoulders of the two groups: 9 tears showed no retraction (Patte 1), while 2 tears were retracted to the humeral head (Patte 2). Five supraspinatus muscles in Group A and three in Group B were graded as Goutallier 1, the remaining being Goutallier 0.

All the surgical procedures were performed under blended anesthesia (interscalene block and narcosis) by a single surgeon. Initially, 11 patients were treated with arthroscopic rotator cuff repair and PRP (Group A) followed by 11 patients treated without PRP (Group B).

Two different techniques were used for the tendon-to-bone repair, depending on the type of lesion and tendon quality:

- (a) Single-row technique with two 6.5 mm Healix Peek® 2-suture anchors (DePuy Synthes Mitek,

Table 1: Demographic data of the patients

Data	Group A	Group B
Number of patients	11	11
Male/female	7/4	8/3
Mean age, years (range)	57 (47-67)	51.4 (37-62)
Right/left shoulder	8/3	8/3
Dominant/nondominant arm	8/3	8/3

Table 2: Clinical parameters of the patients before surgery

Parameter	Group A	Group B	P
Pain (yes/no)	5/6	4/7	>0.05
VAS	8.45±1.96	8.1±1.52	>0.05
Constant score	43.72±6.73	45.4±10.35	>0.05
UCLA score	9±4.12	7.2±3.79	>0.05
Active forward elevation	99.09±27.09	110±22.6	>0.05

VAS=Visual analog scale, University of California at Los Angeles - UCLA

Raynham, MA, USA); (b) suture bridge technique with two medial 6.5 mm Healix Peek® 2-suture anchors and two lateral Versalok® anchors (DePuy Synthes Mitek, Raynham, MA, USA).

In both groups, the single-row technique was used in 4 patients and the suture bridge technique in 7 patients.

Acromioplasty and long head of biceps tenotomy were performed in all patients.

Platelet-rich plasma preparation and administration

Before anesthesia, patients of Group A had a total of 74 ml of blood drawn from a peripheral vein: 54 ml was transferred into a sterile tube containing 6 ml of anticoagulant citrate dextrose solution A 20% while the remaining 20 ml was put into two 10 ml tubes and left to coagulate for 5–10 min.

Anticoagulated blood was then moved to a special disposable tube [Figure 1a] (GPS®III-Plasmax Plus-Platelet Concentration System; Biomet Biologics, Warsaw, IN, USA) and centrifuged at 3200 rpm for 15 min to stratify platelet-poor plasma (PPP) on the top, PRP in the middle layer, and red cells on the bottom of the tube [Figure 1b]. PPP and PRP were retrieved from the tube with a syringe [Figure 1c and d].

The two coagulated tubes were centrifuged at 3200 rpm for 2.5 min, and then the thrombin-rich serum (TRS) on the upper layer (5–6 ml) was aspirated and added with 1 ml of 10% calcium chloride.

PRP (6 ml), PPP (10 ml), and TRS (1 ml) were finally collected [Figure 1e] and transferred into syringes connected to cannula applicators on the sterile surgical field [Figure 1f].

At the end of the arthroscopic procedure, the irrigation fluid in the subacromial space was aspirated and PRP was slowly injected at the interface between the repaired tendon and bone through the lateral portal. Finally, the syringes containing PPP and TRS were assembled with a spray terminal and applied on the sutured arthroscopic portals.

The rehabilitation protocol after the repair was the same for all patients. Opioids were used as analgic therapy. A 20° abduction brace was maintained for 1 month; assisted passive mobilization and hydrokinesis were prescribed 15 days after surgery. Active movements and light activities of daily living were allowed at 1 month. A gradual strengthening program for the deltoid and the rotator cuff was started at 2 months.

All the patients were examined at the following intervals from surgery:

15 days: portals healing, passive range of motion [ROM] and VAS were noted; 1 month: passive ROM and VAS; 3 and 6 months: active and passive ROM and VAS; 1 year: VAS, Constant, UCLA, and MRI (with the same protocol and blind evaluation adopted preoperatively).

Repair integrity was evaluated with MRI 1 year after surgery and was classified in five categories according to Sugaya *et al.*¹⁴

Statistical analysis was carried out using StatSoft statistica 10 software (StatSoft Italia, Padova, Italy). For all comparisons, $P < 0.05$ was considered statistically significant. Differences between Group A and Group B were tested with Mann–Whitney test for continuous variables. Differences for categorical variables were tested with Fisher’s exact test due to the small number of patients. Differences between preoperative and postoperative data in each group were analyzed with Wilcoxon signed-rank test.

Results

Of the 22 patients recruited, 21 completed the study protocol. One patient of Group B refused to perform MRI at followup and therefore the structural integrity of this repair could not be evaluated.

No intraoperative or postoperative complications were observed.

As regards VAS and passive ROM, no differences were found among the two groups 15 days and 1 month after surgery.

Overall, there was a gradual improvement in pain and function in both groups during the study. Active and passive ROM as well as VAS was not significantly different between the two groups at 3 and 6 months.

Comparison of clinical parameters preoperatively and at 1 year postoperatively showed a significant improvement in all the patients [Table 3]. However, clinical outcomes did not show any statistical difference between the two groups [Table 4].

MRI findings at 1 year are reported in Table 5. In two shoulders of Group A and in one shoulder of Group B, a progression from Goutallier 1 to Goutallier 2 was reported. The retear rate (Sugaya type V) was higher in Group B than in Group A (20% vs. 9.1%), but the difference was not statistically significant [Figures 2 and 3].



Figure 1: (a) Tube for centrifugation of 54 ml of anticoagulated blood. (b) Stratified blood components after centrifugation: platelet-poor plasma in the upper layer, platelet-rich plasma in the middle layer, and red cells in the bottom layer. (c) Platelet-poor plasma retrieval from the tube. (d) Platelet-rich plasma retrieval from the tube. (e) Platelet-rich plasma (dotted arrow), platelet-poor plasma (thin arrow), and thrombin-rich serum (large arrow) after collection. (f) The syringes with platelet-rich plasma–thrombin-rich serum and platelet-poor plasma–thrombin-rich serum ready for use

Table 3: Comparison of clinical parameters before surgery and at 1 year after surgery

Parameter	Group A			Group B		
	Preoperative	1 year	P	Preoperative	1 year	P
VAS	8.45±1.96	1.36±1.85	0.0032	8.1±1.52	0.7±1.25	0.0048
Constant score	43.72±6.73	97.9±3.75	0.0033	45.4±10.35	98.5±2.27	0.0050
UCLA score	9±4.12	32.81±2.04	0.0033	7.2±3.79	33.1±2.28	0.0049
Active forward elevation	99.09±27.09	175.45±5.22	0.0033	110±22.6	175±5.27	0.0046

VAS=Visual analog scale, University of California at Los Angeles - UCLA

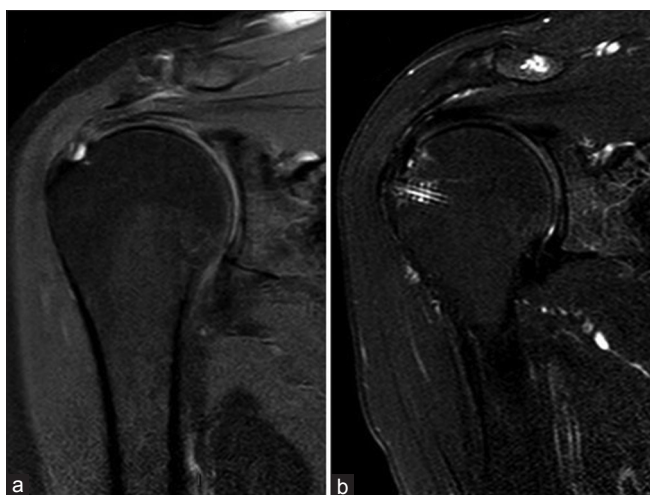


Figure 2: (a) Preoperative magnetic resonance imaging of a full-thickness tear of the supraspinatus (Patte 1) that was repaired with the single-row technique and platelet-rich plasma. (b) Magnetic resonance imaging at 1 year shows structural integrity of the repair with homogeneous tendon signal (Sugaya 1). Constant score of the patient was 100

Table 4: Comparison of clinical outcomes between the two groups 1 year after surgery

Parameter	Group A	Group B	P
VAS	1.36±1.85	0.7±1.25	>0.05
Constant score	97.9±3.75	98.5±2.27	>0.05
UCLA score	32.81±2.04	33.1±2.28	>0.05
Active forward elevation	175.45±5.22	175±5.27	>0.05

VAS=Visual analog scale, University of California at Los Angeles - UCLA

Table 5: Magnetic resonance imaging findings at 1 year

Classification	Group A (%)	Group B (%)
Goutallier		
0	5	7
1	4	2
2	2	1
3	0	0
4	0	0
Sugaya		
I	1	5
II	3	0
III	5	2
IV	1	1
V	1 (9.1)	2 (20)

Discussion

Rotator cuff disease includes a wide variety of anatomical and clinical conditions, ranging from asymptomatic shoulders with partial tears to painful pseudoparalysis with rotator cuff arthropathy. For this reason, there are objective difficulties in evaluating the efficacy as well as the limits of new therapeutic approaches adopted on heterogeneous populations of patients.

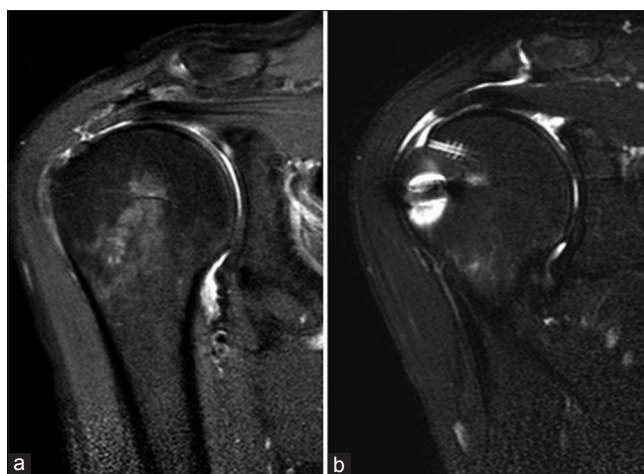


Figure 3: (a) Preoperative magnetic resonance imaging of a supraspinatus tear (Patte 1); the suture bridge technique without platelet-rich plasma was used for the repair. (b) Magnetic resonance imaging at one year shows recurrence of the tear (Sugaya 4). Constant score of the patients was 97

Even if satisfactory clinical outcomes can be achieved after rotator cuff repair regardless of the occurrence of retears, it should be considered that the integrity of the repaired tendons might produce better outcomes in the long term. For this reason, different forms of biological augmentations have been proposed in the attempt to improve tendon-to-bone healing.¹⁵

During the last years, several clinical studies have investigated the role of PRP in arthroscopic cuff repair, but its effectiveness is still a matter of debate.¹⁶

In this prospective study, we aimed to evaluate the role of PRP in a selected population of patients, who underwent arthroscopic repair of isolated supraspinatus tears. Postoperative pain, functional recovery, and MRI findings at 1 year were compared with a second group of patients, who underwent the same surgical procedure without PRP application. Before surgery, it was assessed that the clinical and anatomical conditions of the two groups were similar.

All the patients included in the study experienced improved function and quality of life when compared to preoperative levels.

Our findings are consistent for affirming that PRP application does not provide a noteworthy advantage for the clinical outcome, at least in isolated tears of the supraspinatus. No significant differences among the two groups were observed in the clinical and functional scales (VAS, Constant, and UCLA) during the entire study.

The role of PRP for the structural outcome of the repair is more controversial. The retear rate was higher among patients not receiving PRP (20% vs. 9.1%), but the difference between the two groups was not statistically significant. An important limitation of this study is represented by the small sample size: a larger series of patients should have been studied, considering the low retear rates reported in

recent clinical experiences.¹⁷ However, we aimed to select patients with similar anatomoclinical conditions to limit the variables that could influence the outcome. We did not perform the power analysis.

A potentially biasing factor affecting studies on PRP is the lack of standardization in the preparation procedure: different techniques might result in different platelet and growth factor concentrations as well as in different white blood cells contamination levels.^{18,19} Regardless of the adoption of the same preparation technique, important variations in the quantity and quality of platelets and growth factors can be detected in PRP of different individuals.²⁰ Irrigation and swelling after surgery may also reduce the effectiveness of PRP after arthroscopic procedures. One of the prerequisites of this study was to adopt the same protocol in PRP preparation and injection for all the patients, but we did not assess the actual concentration of platelets and growth factors achieved in the PRP of every single patient.

Considering that the costs related to PRP application are not negligible,²¹ we conclude that this study does not provide any evidence to support the use of PRP in arthroscopic repair of isolated supraspinatus tears. Postoperative pain control, functional recovery, and short term clinical results were not influenced by PRP. In accordance with other studies, the retear rate was lower in the PRP group, but not statistically significant. Further investigations should be carried out to verify if the potential improvement in the healing process provided by PRP can be increased by a more accurate selection of patients and if the structural integrity of the repair results in better outcomes in the long term.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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