Systematic Review

# The Role of Platelet-Rich Plasma in Arthroscopic Rotator Cuff Repair: A Systematic Review With Quantitative Synthesis

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**Purpose:** Despite the theoretic basis and interest in using platelet-rich plasma (PRP) to improve the potential for rotator cuff healing, there remains ongoing controversy regarding its clinical efficacy. The objective of this systematic review was to identify and summarize the available evidence to compare the efficacy of arthroscopic rotator cuff repair in patients with full-thickness rotator cuff tears who were concomitantly treated with PRP. **Methods:** We searched the Cochrane Central Register of Controlled Trials, Medline, Embase, and PubMed for eligible studies. Two reviewers selected studies for inclusion, assessed methodologic quality, and extracted data. Pooled analyses were performed using a random effects model to arrive at summary estimates of treatment effect with associated 95% confidence intervals. **Results:** Five studies (2 randomized and 3 nonrandomized with comparative control groups) met the inclusion criteria, with a total of 261 patients. Methodologic quality was uniformly sound as assessed by the Detsky scale and Newcastle-Ottawa Scale. Quantitative synthesis of all 5 studies showed that there was no statistically significant difference in the overall rate of rotator cuff retear between patients treated with PRP and those treated without PRP (risk ratio, 0.77; 95% confidence interval, 0.48 to 1.23). There were also no differences in the pooled Constant score; Simple Shoulder Test score; American Shoulder and Elbow Surgeons score; University of California, Los Angeles shoulder score; or Single Assessment Numeric Evaluation score. **Conclusions:** PRP does not have an effect on overall retear rates or shoulder-specific outcomes after arthroscopic rotator cuff repair. Additional well-designed randomized trials are needed to corroborate these findings. **Level of Evidence:** Level III, systematic review of Level I, II, and III studies.

Rotator cuff tears are a common cause of shoulder pain, and it has been estimated that greater than 75,000 rotator cuff repairs are performed annually in the United States.[1,2] Over the last 2 decades, the surgical treatment of rotator cuff tears has evolved from open repair with transosseous sutures to, more recently, all-arthroscopic techniques including single-row, double-row, and transosseous-equivalent suture

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anchor constructs.[3] Despite variations in technique, the emphasis over this period has largely been on biomechanical principles and optimizing the strength of the repair. Gerber et al.[4] have proposed that an ideal rotator cuff tear would have high initial fixation strength, permit minimal gap formation, and sustain mechanical stability until healing has occurred.[5] Additional work has been focused on the utilization of stronger sutures, knot-tying techniques, and recreation of the footprint through double-row repairs.[3] A recent meta-analysis by Dehaan et al.[5] showed a strong trend ($P = .057$) toward higher failure rates in patients undergoing single-row compared with double-row rotator cuff repair, which is consistent with the superiority of double-row repairs that has been observed in biomechanical studies.[6] However, even in patients undergoing double-row repairs, the pooled retear rate (partial and complete) has been estimated to be 27.3%,[5] which suggests that the intrinsic potential of the rotator cuff to heal back to the rotator cuff footprint after repair remains a valid concern.

Despite improvements in pain and function after rotator cuff repair, tendon failure has been historically reported to be 11% to 95% at 2-year follow-up.[1] Other than the biomechanical causes highlighted earlier, additional factors associated with retear after rotator cuff repair include patient-related factors (e.g., increasing patient age, tear size, tissue quality, systemic disease, and smoking), extrinsic factors (e.g., overaggressive postoperative rehabilitation), and biological factors (e.g., failure to restore normal histology at the repair site).[1,7] Although improved biomechanics may modestly improve healing, it appears that biological augmentation of the healing process needs to be investigated to further reduce failure rates by improving tendon-to-bone integration.[8] Biological strategies that are currently under investigation include the use of growth factors and cytokines, gene therapy, tendon augmentation grafts/scaffolds, and tissue engineering with mesenchymal stem cells.[8]

The use of platelet-rich plasma (PRP) or platelet-rich fibrin matrix as a biological solution to improve rotator cuff tendon healing has gained popularity over the last several years. PRP, most simply defined as a sample of autologous blood with concentrations of platelets above baseline values, can be applied by either direct injection or physical application of a PRP matrix scaffold to repaired tissues.[9-11] After an initial release of growth factors from alpha granules, administered platelets will go on to synthesize and secrete additional factors for 7 to 10 days, which coincides with the inflammatory and repair phases of tendon healing.[8,11] Although there is variability among different commercially available products, the main growth factors in PRP are transforming growth factor $\beta$1, platelet-derived growth factor, vascular endothelial growth factor, hepatocyte growth factor, and insulin-like growth factor 1. These autologous growth factors may play a role in regeneration of tendon tissue through increased tendon cell proliferation, collagen synthesis, and vascularization.[1,11] At present, there are ample basic science and animal data that have shown the positive effect of PRP on tendon collagen deposition and tendon vascularization.[12-14]

Despite the strong theoretic basis and interest in using PRP to improve the potential for rotator cuff healing, there remains ongoing controversy regarding the clinical efficacy of PRP. To our knowledge, there is no systematic review published in the literature that has addressed this controversy. The objective of this systematic review was to identify and summarize the available evidence to determine the efficacy of arthroscopic rotator cuff repair in patients with full-thickness rotator cuff tears who were concomitantly treated with PRP. We hypothesized that there would be no difference in retear rates or functional outcomes among patients who did receive administration of PRP during arthroscopic repair of full-thickness rotator cuff tears and those who did not.

## METHODS

### Inclusion Criteria

**Types of Studies and Interventions:** Published randomized controlled trials, as well as cohort studies with a comparative control group, that analyzed the efficacy of PRP in patients undergoing arthroscopic repair of full-thickness rotator cuff tears were included. A minimum of 1 year of clinical follow-up was also required for inclusion.

**Types of Participants:** Patients aged 18 years or older diagnosed with a full-thickness tear of at least 1 rotator cuff tendon were included.

### Outcomes

The primary outcome of interest was the rotator cuff retear rate after arthroscopic rotator cuff repair (binomial variable). Secondary outcomes of interest (when available) included (1) disease-specific quality of life as measured by the Western Ontario Rotator Cuff index and (2) shoulder-specific patient-reported outcome measures (continuous variables) including the Disabilities of the Arm, Shoulder and Hand question-

naire[15,16]; University of California, Los Angeles (UCLA) outcome score[17]; Constant-Murley outcome score[18]; Pennsylvania Shoulder Score[19]; American Shoulder and Elbow Surgeons (ASES) outcome score[20]; Simple Shoulder Test (SST) score[21]; L'Insalata scoring system[22]; and visual analog scale for pain.

### Search Strategy

We used a text search strategy using the terms "rotator cuff AND (platelet OR platelet-rich OR PRP)." Specifically, we searched the Cochrane Central Register of Controlled Trials (fourth quarter of 2011), Medline (1946 to week 3 of December 2011), Embase (1980 to week 52 of 2011), PubMed (December 30, 2011), and www.clinicaltrials.gov for completed and ongoing randomized controlled trials. We also assessed the bibliographies of identified studies to seek additional articles. We did not restrict our search or inclusion by language. The final list of eligible studies was reviewed with content experts to ensure that there were no missing published manuscripts relevant to this review.

### Study Selection

The primary author parsed through all citations and abstracts generated by the literature search and applied selection criteria with a tendency toward inclusion for published manuscripts. Identified studies were subsequently assessed by 2 reviewers for inclusion. Each investigator independently assessed each full report to determine whether it met the inclusion criteria. Disagreements were resolved by discussion and consensus. Titles of journals and names of authors or supporting institutions were not masked at any stage.

### Data Extraction and Management

Data were extracted independently from included studies by 2 reviewers on data abstraction forms. All extracted data were imported into a meta-analysis software package (RevMan version 5.1; The Cochrane Collaboration, Oxford, England) for statistical pooling and analysis.

### Assessment of Risk of Bias in Included Studies

The Detsky scale was used to evaluate the quality of included randomized controlled trials in this study.[23] The Detsky scale is a 21-item instrument (22 for negative trials) and has been used previously to grade orthopaedic randomized controlled trials on several domains, including randomization (out of 4), outcome measurement and blinding (out of 4), inclusion and exclusion criteria (out of 4), description of treatment (out of 4), and statistical methodology (out of 4 if a positive trial; out of 5 if a negative trial).[24] The Newcastle-Ottawa Scale (NOS)[25] was used to evaluate nonrandomized (case-control and cohort) studies. The NOS uses a star system (out of 9 stars) to allow a semiquantitative assessment of study quality for the following domains: selection (0 to 4 stars), comparability (0 to 2 stars), and outcome/exposure (0 to 3 stars). For both the Detsky scale and NOS, higher scores represent higher study quality. Two review authors independently scored the methodologic quality of included studies. Consensus agreement was achieved between reviewers.

### Analysis

For binary outcomes, the pooled risk ratio (RR) was calculated. For continuous outcomes, the mean difference was calculated. Ninety-five percent confidence intervals (CIs) were calculated for all point estimates. The number needed to treat for statistically significant binomial outcomes was determined, along with their 95% CIs. The $I^2$ statistic[26] was used to quantify heterogeneity, whereas the Cochran $\chi^2$ test of homogeneity (i.e., Q test, $P < .10$) was used to test for heterogeneity.

Data from eligible studies were pooled using a random effects model ($v$ fixed effects) because of the anticipated heterogeneity across individual study populations and across rotator cuff repair techniques, as well as differences in PRP formulations and delivery methods of such products and differences in postoperative physical therapy protocols. Subgroup analyses that were planned a priori included analyzing retear rates based on the size of rotator cuff tears and the use of single-row versus double-row repair techniques.

A sensitivity analysis was used by removing 1 study at a time from the pooled analysis for rotator cuff retears and functional outcome, as well as by performing subgroup analyses based on study randomization. In situations where studies reported median and range data, established statistical methods were used to obtain converted mean and standard deviation values so that data could be pooled across studies.[27]

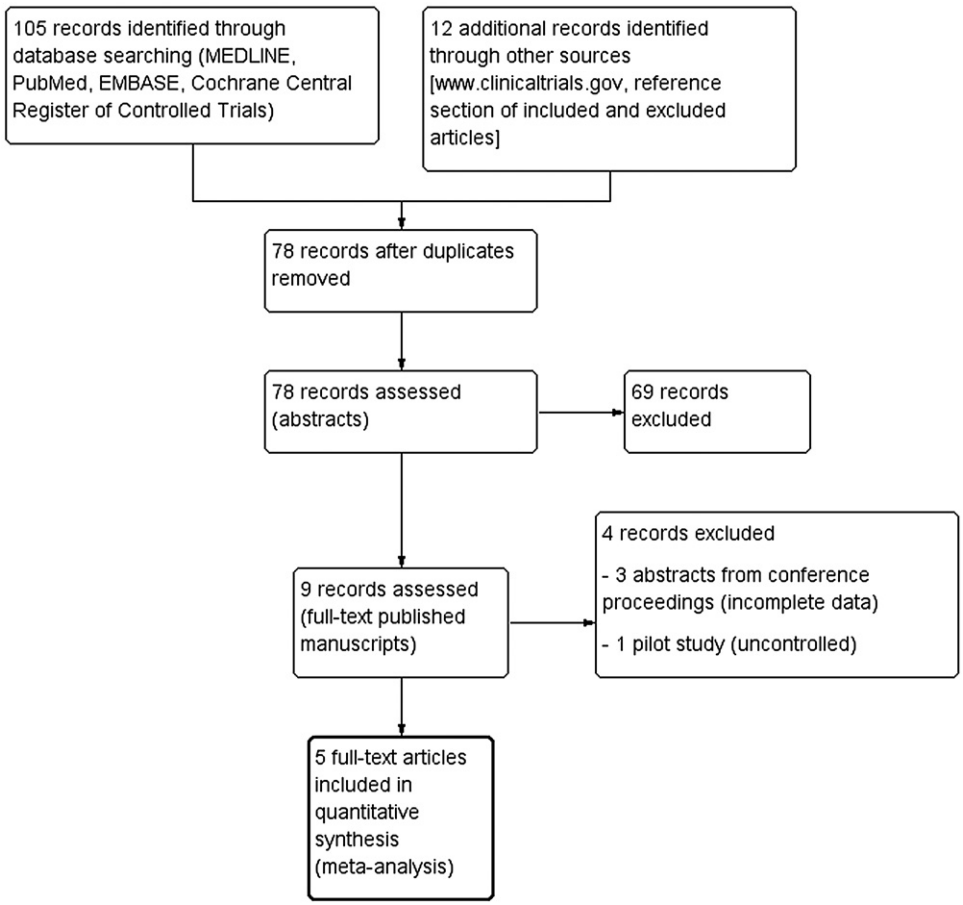


**FIGURE 1.** Search strategy results.

## RESULTS

### General Study Characteristics

The results of the search, the study selection log, and the number of studies are reported in Fig 1. We included 2 Level I randomized controlled trials,[28,29] 1 case-control study,[30] 1 prospective cohort study with a concurrent control group,[31] and 1 prospective cohort study with a historical control group[32] in this review. The baseline characteristics of included studies are reported in Table 1.

The mean clinical follow-up across the 5 included studies ranged from 18.9 to 31 months, whereas the mean radiologic follow-up ranged from 4 to 22 months. In total, the 5 included studies had a total enrollment of 261 patients. Data pertaining to sex were available in 4 studies,[28-31] and 107 of 223 patients (48%) were men. The overall clinical and radiologic follow-up rates were 96.6% (252 of 261 patients) and 88.9% (232 of 261 patients), respectively. The mean age of the participants across all studies was 58.9 years. All studies determined the rate of retear after arthroscopic rotator cuff repair. Magnetic resonance imaging was used for postoperative imaging in 4 studies,[28,30-32] whereas 1 study used a combination of magnetic resonance imaging and ultrasound (3 patients).[29] The specific definitions used to identify a retear are listed in Table 1. The most commonly reported shoulder-specific outcome measures were the total Constant score (all 5 studies), SST score,[29-31] ASES score,[30-32] UCLA shoulder score,[29,31,32] and Single Assessment Numeric Evaluation (SANE) score.[30,32]

The definition of small- and medium-sized tears for this review was derived from the definitions put forth in the included studies. Three studies identified small- and medium-sized tears as those measuring less than 3 cm in the anteroposterior dimension.[28,30,31] In the study by Randelli et al.,[29] tears were graded according to the amount of retraction. If the tear exposed the humeral head but did not retract all the way to the glenoid surface, it was defined as a small- or medium-sized tear. Tears

**TABLE 1.** *Baseline Characteristics of Included Studies*

| Study | Study Design | Inclusion Criteria | Details of Surgery | PRP Formulation | Sample Size (% Male) | Mean Age (yr) | Follow-up Rate (%) | Mean Follow-up (mo) | Outcome Measures | Definition of Rotator Cuff Retear |
|---|---|---|---|---|---|---|---|---|---|---|
| Castricini et al.[28] (2011) | Level I randomized | Isolated repairable supraspinatus tear | DR<br>1 Medial double-loaded anchor + 2 lateral-row anchors | Cascade PRP fibrin matrix construct (Musculoskeletal Transplant Foundation) | 88 (45.5) | 55.3 | Clinical, 100<br>MRI, 88.6 | 20.2 | Constant score (primary outcome)<br>Retear rate—MRI | Full-thickness tear defined as absence of visible tendon fiber extending across entire tendon from inferior to superior |
| Randelli et al.[29] (2011) | Level I randomized | FTRCT confirmed intraoperatively (all sizes) | SR<br>Mean no. of SA, 2 (PRP) or 1.6 (no PRP) | GPS II (Plasmax Platelet Concentration System; Biomet Biologics) | 53 (39.6) | 60.5 | Clinical and MRI/US, 85 | Clinical, 24<br>MRI/US, 21 with PRP and 23 with no PRP | Constant score (primary outcome)<br>SST score<br>UCLA score<br>VAS score for pain<br>Retear rate—MRI and US | Lack of continuity of tendon in 1 slice of coronal plane; very thin bands of tissue were identified as failure of healing |
| Barber et al.[30] (2011) | Level III case-control study | 1- or 2-tendon FTRCT measuring 10-50 mm in width; stage 2 FI or lower | SR<br>1 or 2 double-loaded SA | Cascade PRP fibrin matrix construct (Musculoskeletal Transplant Foundation) | 40 (67.5) | 57 | 100 | Clinical, 31<br>MRI, 4 | ASES score<br>Constant score<br>Rowe score<br>SANE score<br>SST score<br>Retear rate—MRI (primary outcome) | Full-thickness rotator cuff defect |
| Bergeson et al.[32] (2012) | Level III prospective cohort with historical control | High-risk tears included per algorithm score ≥3*; minimum age, 50 yr; minimum tear size, 2 cm | SR in majority<br>Mean no. of SA, 2.9 in PRP/no PRP groups | Cascade PRP fibrin matrix construct (Musculoskeletal Transplant Foundation) | 38 (NR) | 65.0 | Clinical and MRI, 97.3 | Clinical, 12 for PRFM and 27 for no PRFM MRI, 12 | ASES score<br>Constant score<br>SANE score<br>UCLA score<br>WORC score<br>Retear rate—MRI | Full-thickness defect in repaired tendon in which no fibers were visualized spanning defect in any MRI plane |
| Jo et al.[31] (2011) | Level II prospective cohort with concurrent control | FTRCT (all sizes) | DR suture bridge technique<br>2-5 medial-row SA + lateral-row anchors | Plateletpheresis system with leukoreduction set (COBE Spectra LRS Turbo; Caridian BCT) | 42 (45.2) | 60.7 | Clinical, 100<br>MRI, 76.2 | 18.9 for PRP<br>20.3 for no PRP | ASES score<br>Constant score<br>DASH score<br>SPADI<br>SST score<br>UCLA score<br>Retear rate—MRI | Sugaya method[33]; type IV/V—presence of minor or major discontinuity in repaired tendon |

Abbreviations: DASH, Disabilities of the Arm, Shoulder and Hand; DR, double row; FI, fatty infiltration; FTRCT, full-thickness rotator cuff tear; MRI, magnetic resonance imaging; NR, not reported; PRFM, platelet-rich fibrin matrix; SA, suture anchors; SPADI, Shoulder Pain and Disability Index; SR, single row; US, ultrasound; VAS, visual analog scale; WORC, Western Ontario Rotator Cuff index.

*For the algorithm score, points were assigned for age (1 point for 50 to 59 years, 2 points for 60 to 69 years, and 3 points for ≥70 years), anterior-to-posterior tear size (0 points for 2 to 2.9 cm, 1 point for 3 to 3.9 cm, and 2 points for ≥4 cm), and fatty atrophy (0 points for Goutallier score of 0 to 2 and 1 point for Goutallier score of 3 or 4).

that retracted past the glenoid were classified as large tears. Finally, in the study by Bergeson et al.,[32] all tears were considered to be large, "at-risk" tears per the study eligibility criteria (Table 1).

Three different PRP formulations were used in the included studies. Three studies treated patients with the Cascade Autologous Platelet System (Musculoskeletal Transplant Foundation, Edison, NJ),[28,30,32] whereas 1 study group developed and used a fully automated plateletpheresis system with a leukoreduction set (COBE Spectra LRS Turbo; Caridian BCT, Lakewood, CO).[31] Whereas the former platelet-rich formulation results in the production of a platelet-rich fibrin matrix, the latter product results in a PRP gel—both of these constructs are sutured into the repair site. The fifth study used GPS II (Plasmax Platelet Concentration System; Biomet Biologics, Warsaw, IN), which is an injectable form of PRP.[29]

The details of the methodologic quality assessment of included studies using the Detsky scale and NOS are presented in Tables 2 and 3, respectively. In general, both of the randomized controlled trials had adequate allocation concealment and sequence generation procedures; in addition, they used the intention-to-treat principle for statistical analysis. All 5 studies had a blinded evaluation of clinical and radiologic results. The nonrandomized studies had well-matched cohort and control groups (within studies) that were comparable in terms of demographics, prognostic variables (including rotator cuff tear size), and surgical techniques. Publication bias could not be assessed because of the small number of included studies.

**Table 2.** *Detsky Score for Randomized Controlled Trials*

| | Castricini et al.[28] (2011) | Randelli et al.[29] |
|---|---|---|
| Randomization (total out of 4) | | |
| Were patients assigned randomly? (1) | 1 | 1 |
| Was randomization adequately described? (2) | 2 | 2 |
| Was treatment group concealed to investigator? (1) | 1 | 1 |
| Outcome measurement and blinding (total out of 4) | | |
| Was description of outcome measurement adequate? (1) | 1 | 1 |
| Were outcome measurements objective? (2) | 2 | 2 |
| Were assessors blind to treatment? (1) | 1 | 1 |
| Inclusion and exclusion criteria (total out of 4) | | |
| Were inclusion/exclusion criteria well defined? (2) | 2 | 2 |
| Was number of patients excluded and reason given? (2) | 2 | 2 |
| Description of therapy (total out of 4) | | |
| Was therapy fully described for treatment group? (2) | 2 | 2 |
| Was therapy fully described for controls? (2) | 2 | 2 |
| Statistics (total out of 4 if positive trial, total out of 5 if negative trial) | | |
| Was test stated, and was there a *P* value? (1) | 1 | 1 |
| Was statistical analysis appropriate? (2) | 2 | 2 |
| If trial was negative, were CIs or post hoc power calculations performed? (1 if applicable) | 0 | Not applicable |
| Was sample size calculation performed before study? (1) | 1 | 1 |
| Follow-up rates | | |
| >80% follow-up (1), <80% follow-up (0) | 1 | 1 |
| Total score (out of 21 or 22) | 21/22 | 21/21 |

## Effects of Interventions

**Primary Outcome—Rate of Rotator Cuff Retear:** The pooled retear rate among all patients in this study was 31.0% (72 of 232). The overall pooled retear rate was 25.6% (29 of 113) and 36.1% (43 of 119) for patients treated with PRP and those treated without PRP, respectively. A quantitative synthesis of all 5 trials showed that there was no statistically significant difference in the overall risk of retear between patients treated with PRP and those treated without PRP (5 studies; RR, 0.77; 95% CI, 0.48 to 1.23) (Fig 2A).

The rate of retear for small- and medium-sized rotator cuff tears was 7.9% and 26.8% for patients treated with PRP and those treated without PRP, respectively. This subgroup analysis showed that with the use of PRP, the rate of retear was significantly lower in patients with small- and medium-sized rotator cuff tears (4 studies; RR, 0.32; 95% CI, 0.14 to 0.72; $P = .006$; $I^2 = 0\%$) (Fig 2B). The number of patients (with small/medium tears) who needed to be treated to benefit (NNTB) with PRP to prevent 1 episode of retear was 6 patients (NNTB, 6; 95% CI, 3 to 33). There was no difference in retear rates among patients who had large or at-risk tears regardless of PRP treatment status (4 studies; RR, 0.94; 95% CI, 0.67 to 1.31) (Fig 2C).

**TABLE 3.** *NOS Scores for Case-Control and Cohort Studies*

| | Barber et al.[30] (2011) | Bergeson et al.[32] (2012) | Jo et al.[31] (2011) |
|---|---|---|---|
| Selection | 4 stars | 3 stars | 4 stars |
| Comparability | 0 | 2 stars | 0 |
| Exposure/outcome | 3 stars | 3 stars | 3 stars |
| Total | 7 stars | 8 stars | 7 stars |

An additional subgroup analysis was performed for studies in which patients underwent a double-row rotator cuff repair.[28,31] In this subgroup the rate of retear was 9.1% and 20.0% for patients treated with PRP and those treated without PRP, respectively. This risk of retear was not significantly different in patients treated with and without PRP (RR, 0.54; 95% CI, 0.22 to 1.35; $P = .19$).

Sensitivity analysis showed that there was no significant difference in the overall retear rate when the results from Level I studies were pooled alone (2 studies; RR, 0.65; 95% CI, 0.27 to 1.58) or when the results from nonrandomized studies were pooled alone (3 studies; RR, 0.81; 95% CI, 0.40 to 1.64). However, when the results for small- and medium-sized tears underwent a similar analysis, pooled results for Level I studies showed a trend toward lower retear rates in patients treated with PRP (2 studies; RR, 0.33; 95% CI, 0.10 to 1.08; $P = .07$; $I^2 = 0\%$). The pooled analysis from nonrandomized studies for small- and medium-sized tears showed a significantly lower retear rate among patients treated with PRP (2 studies; RR, 0.31; 95% CI, 0.10 to 0.95; $P = .04$; $I^2 = 0\%$).

**Secondary Outcomes:** A quantitative synthesis of the included studies showed that treatment with PRP did not result in significant differences in shoulder-specific outcome scores among patients undergoing rotator cuff repair. Specifically, there were no differences in the Constant score (mean difference, 0.48; 95% CI, −1.96 to 2.92), SST score (mean difference, 0.12; 95% CI, −0.39 to 0.63), ASES score (mean difference, 1.15; 95% CI, −3.56 to 5.87), UCLA shoulder score (mean difference, 1.15; 95% CI, −0.20 to 2.50), or SANE score (mean difference, 1.56; 95% CI, −3.61 to 6.73). Furthermore, all subgroup (double

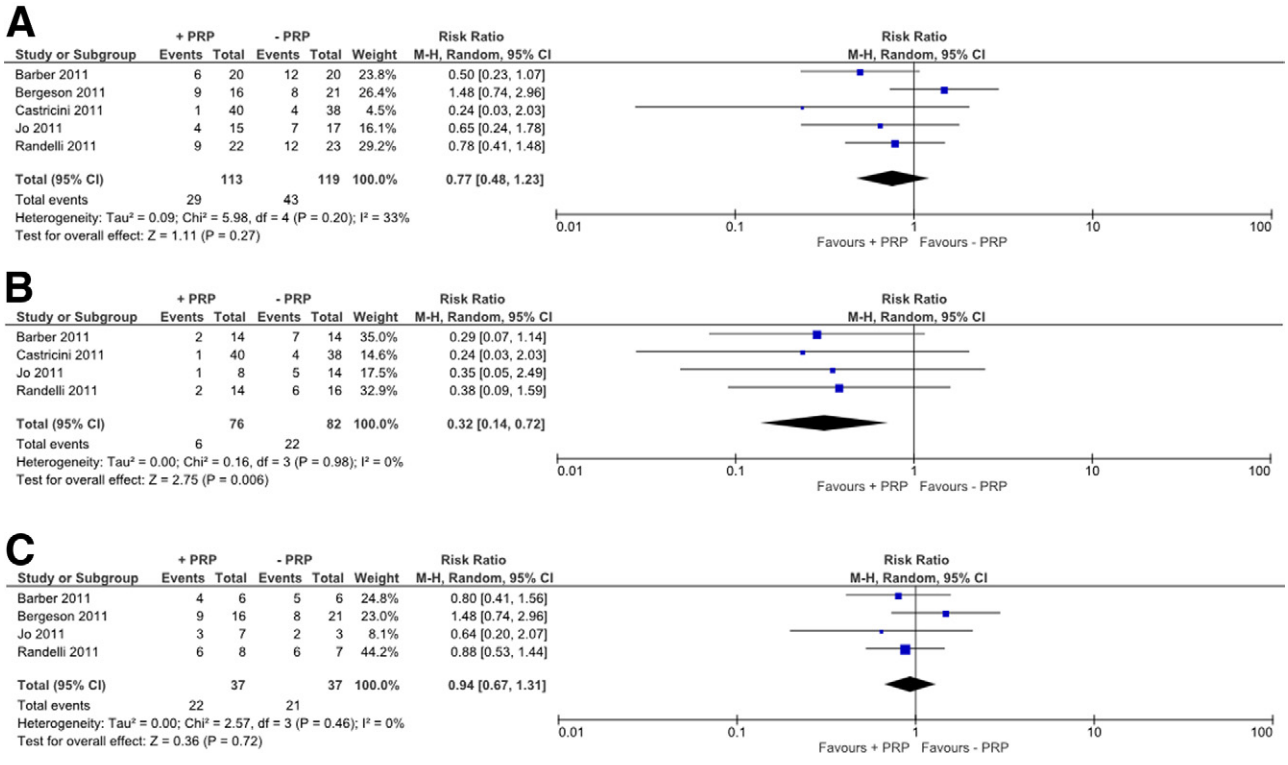


**FIGURE 2.** Forest plots illustrating results of quantitative synthesis for rate of retear in patients treated with PRP and those treated without PRP during arthroscopic repair of full-thickness rotator cuff tears. (A) Overall retear rate. (B) Retear rate for small-/medium-sized tears. (C) Retear rate for large or at-risk tears. (M-H, Mantel-Haenszel.)

row *v* single row) and sensitivity analyses for the Constant score did not show any statistically significant differences.

Although a formal quantitative synthesis could not be performed for the Western Ontario Rotator Cuff index or the Shoulder Pain and Disability Index, there were no statistically significant differences in the individual reported studies.[31,32] However, Barber et al.[30] did show significantly higher Rowe scores among patients treated with PRP.

Bergeson et al.[32] showed 2 cases of infection (12.5%) among patients treated with platelet-rich fibrin matrix compared with no cases of infection in the control group. There were no differences in infection rates or complication rates in the remainder of the 4 studies.

## DISCUSSION

The objective of this systematic review was to identify, summarize, and combine the available published literature related to the use of PRP during arthroscopic repair of full-thickness rotator cuff tears. The quantitative synthesis in this study showed that the use of PRP during rotator cuff repair did not have an effect on the overall retear rates or on several shoulder-specific outcome measures, including the Constant score, ASES score, UCLA shoulder score, SANE score, or SST score. However, there was a decrease in the rate of retear observed among patients treated with PRP in the setting of small- and medium-sized rotator cuff tears.

The pooled retear rate among all patients in this study was 31.0%, which is consistent with the findings reported in the literature.[2,5-8,34-37] The overall retear rate among patients treated with PRP was 25.6%. Among patients treated with PRP who had small- or medium-sized rotator cuff tears, the retear rate was further reduced to 7.9%. The latter finding is encouraging because it suggests that biological adjuvants, such as PRP in the context of this review, may be beneficial in improving the healing of the rotator cuff to the humeral footprint.

Preoperative factors that have been suggested to be predictive of higher retear rates include age greater than 65 years, number of tendons involved, large tear sizes, preoperative duration of symptoms, and preoperative stage of fatty degeneration.[7,30] In our review, despite a limited sample size in this subgroup, PRP did not have a beneficial effect on healing rates in patients with large, at-risk tears. This may suggest that further work is required in understanding which biological factors may optimize healing for these difficult cases.

With regard to functional outcomes, there were no differences in any of the shoulder-specific outcome measures used in the included studies. This is consistent with the fact that PRP did not affect overall retear rates in the setting of rotator cuff repair. However, because shoulder-specific functional outcome data were not available for patient subgroups (small/medium *v* large tears; single row *v* double row), definitive conclusions about the effect of PRP on functional outcomes within these subgroups cannot be made at this time.

The clinical heterogeneity among studies represents a valid concern. Of the studies, 3 used single-row repair techniques whereas 2 used double-row techniques. There were also differences in rotator cuff tear sizes and the number of tendons involved among the 5 studies. Furthermore, 3 different PRP products were used among the studies included in this review. Differences among various commercial PRP products include the volume of autologous blood that is drawn, centrifuge rates, single- versus double-spin cycles, the need for an activator, and white blood cell concentrations, as well as final platelet and growth factor concentrations.[10,11] Despite the observed clinical heterogeneity, there was no significant statistical heterogeneity for both our primary and secondary outcomes, as indicated by $I^2$ values lower than 50%.

The strength of this systematic review is that all of the included studies are of sound quality as measured by validated scales. All outcomes were assessed independently by blinded personnel across the 5 studies. Retear rates and Constant scores were reported in all 5 studies, and as such, the conclusions with regard to these outcomes measures are supported by a larger sample size. However, there are also several limitations. First, because all of the included studies are not Level I randomized trials, a true "meta-analysis" could not be performed. We have used the term "quantitative synthesis" to describe the pooled analysis across the eligible studies in this review. The reason we included randomized and nonrandomized studies was to increase the sample size and power of our pooled analysis. Next, we recognize that the reported effectiveness of PRP cannot be generalized across all preparation systems, given the intrinsic variability among different commercial products. Finally, despite pooling of 5 studies, the overall sample size for the pooled analysis of our primary outcome (retear rate) was 232 patients. With this sample size, the current pooled analysis is powered to detect a differ-

ence in retear rates between treatment groups if that difference is greater than approximately 15% (baseline retear rate, 30%; power, 80%; $\alpha$, .05). Hence, even by combining the results from 5 studies of sufficient quality, the current quantitative synthesis is not adequately powered to detect smaller differences in retear rates.

Future efforts must include conducting larger, multicenter trials that stratify for important prognostic variables such as rotator cuff tear size and chronicity. Unlike the majority of included trials in this study, such a study would be optimally powered to detect differences in both retear rates and functional outcome scores.

## CONCLUSIONS

PRP does not have an effect on overall retear rates or shoulder-specific outcomes after arthroscopic rotator cuff repair. Additional well-designed randomized trials are needed to corroborate these findings.

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