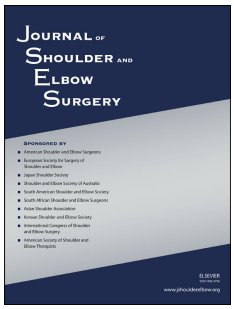
Journal Pre-proof



Leukocyte-Poor Platelet-Rich Plasma Reduces Retear Risk After Arthroscopic Rotator Cuff Repair: A Meta-Analysis with Mechanistic and Economic Evaluation

Quinn Dunivan, BS, Michael Allen, BS, Brian E. Caplan, BA, Brian J. Cole, MD, MBA

PII: S1058-2746(26)00115-1

DOI: https://doi.org/10.1016/j.jse.2026.02.018

Reference: YMSE 7691

To appear in: *Journal of Shoulder and Elbow Surgery*

Received Date: 10 October 2025

Revised Date: 9 February 2026

Accepted Date: 12 February 2026

Please cite this article as: Dunivan Q, Allen M, Caplan BE, Cole BJ, Leukocyte-Poor Platelet-Rich Plasma Reduces Retear Risk After Arthroscopic Rotator Cuff Repair: A Meta-Analysis with Mechanistic and Economic Evaluation, *Journal of Shoulder and Elbow Surgery* (2026), doi: https://doi.org/10.1016/j.jse.2026.02.018.

Full Title:

Leukocyte-Poor Platelet-Rich Plasma Reduces Retear Risk After Arthroscopic Rotator Cuff Repair: A Meta-Analysis with Mechanistic and Economic Evaluation

Short Running Title:

Formulation-Specific PRP Meta-Analysis

Authors:

Quinn Dunivan BS[1], Michael Allen BS[1], Brian E Caplan BA[2], Brian J Cole MD, MBA[2]

Affiliations:

[1]University of Illinois College of Medicine – Chicago

[2]Rush University Medical Center – Chicago

Corresponding Author:

Quinn Dunivan

University of Illinois College of Medicine – Chicago

Email: qduni@uic.edu

Word Count (Main Text): 2908 words

Figures: 6 (plus 4 supplemental figures)

Tables: 0 (plus 1 supplemental table)

Abstract

Background:

Rotator cuff repair (RCR) is one of the most common orthopedic procedures, yet 20–40% of repairs fail structurally within two years, leading to pain, functional decline, and costly revision surgery. Platelet-rich plasma (PRP) has been proposed to enhance tendon–bone healing, but prior reviews frequently pooled heterogeneous formulations as a homogeneous intervention, producing conflicting conclusions. This review aimed to clarify formulation-specific effects within the PRP literature and, where benefit is observed, examine the biological rationale and practical economic implications for surgical adoption.

Methods:

A systematic review and meta-analysis were conducted in accordance with PRISMA 2020 guidelines. PubMed and Embase were searched through July 2025 for comparative clinical studies of intraoperative PRP augmentation during arthroscopic RCR with imaging-confirmed retear outcomes. Risk of bias was assessed using ROB2 (RCTs) and ROBINS-I (nonrandomized studies). Random-effects models (REML; Hartung–Knapp) pooled risk ratios (RRs) for structural failure and, secondarily, mean differences in patient-reported outcomes (PROMs). Prespecified subgroups included PRP formulation, tear size, and follow-up duration; sensitivity analyses excluded high-risk and atypical studies. Publication bias was evaluated with Egger's regression and trim-and-fill. A pragmatic U.S. payer–perspective cost-consequence model estimated revision-related economic impact using pooled absolute risk reduction (ARR), number

needed to treat (NNT), amortized per-case PRP setup costs, and reported reoperation rates after RCR.

Results:

Twenty-one studies (1,279 patients) were synthesized. PRP reduced retear risk with moderate heterogeneity (RR 0.74, 95% CI 0.55–0.99; $I^2 \approx 29\%$). Across formulations, LP-PRP demonstrated the clearest reduction; inclusion of one critically biased trial increased heterogeneity ($I^2 = 53.3\%$), whereas its exclusion yielded a precise, homogeneous estimate (RR 0.37, 95% CI 0.19–0.73; $I^2 = 0\%$). Benefit was most evident in medium-sized tears (RR 0.68, 95% CI 0.48–0.96). PROMs did not improve consistently. Publication-bias diagnostics suggested small-study effects (Egger $p = 0.017$); trim-and-fill ($k_0 = 8$) yielded an exploratory adjusted RR of 0.91 (95% CI 0.69–1.19). Using an ARR of 11.8% (NNT 9) for LP-PRP, economic modeling projected substantial reductions in structural failures, with cost neutrality or net savings achievable under low-cost preparation strategies when scaled by reported revision probabilities.

Conclusion:

Leukocyte-poor PRP augmentation during arthroscopic RCR is associated with reduced structural retear rates, with the most consistent benefit observed in medium-sized tears and no reliable improvement in PROMs. The economic value of LP-PRP is conditional rather than uniform and depends on revision probability and preparation cost. When applied using low-cost preparation methods, LP-PRP may achieve cost neutrality or modest savings, supporting selective adoption as a structural safeguard rather than a symptomatic modifier.

Level of Evidence: Level III, Systematic Review/Meta-analysis, Treatment Study

Keywords: Platelet-Rich Plasma; Rotator Cuff Repair; Tendon Healing; Meta-analysis; Orthobiologics; Health economics

Rotator cuff repair (RCR) is one of the most commonly performed orthopedic procedures, yet structural failure remains a persistent challenge. Despite technical advances, 20–40% of repairs exhibit radiologic retears within two years, often resulting in pain, functional decline, and costly revision surgery.[1] National utilization data show that more than 300,000 RCRs are performed annually in the United States, with a rising comorbidity burden among patients.[18,47] Given these clinical and economic stakes, strategies to improve tendon–bone healing have garnered substantial interest.

Platelet-rich plasma (PRP) has emerged as a promising biologic adjunct due to its autologous nature, ease of preparation, and capacity to deliver supraphysiologic concentrations of growth factors to the repair site. However, PRP is not a single entity. Formulations differ widely in leukocyte content, fibrin structure, and processing protocols, resulting in distinct biological effects.[12,36] This variability reflects both a lack of standardized preparation methods and the absence of definitive evidence favoring one protocol over another.[5] Leukocyte-poor PRP (LP-PRP) is enriched in regenerative cytokines while minimizing pro-inflammatory mediators, whereas leukocyte-rich PRP (LR-PRP) contains higher leukocyte levels that may promote inflammation, fibrosis, and scar-dominated healing.[22,28,46] These distinctions may directly influence tendon–bone integration and long-term repair durability.

Prior systematic reviews and meta-analyses have generally treated PRP as a uniform intervention, leading to conflicting conclusions.[2,11] While some reported modest reductions in retear rates, others found only transient or inconsistent improvements in pain and function, leaving uncertainty around recommendations pertaining to clinical adoption. Notably, prior publications have not integrated mechanistic rationale with formulation-specific clinical

outcomes or downstream economic considerations. This disconnect limits pragmatic decision-making for both surgeons and payers.

To address this gap, we conducted a systematic review and meta-analysis examining whether intraoperative PRP reduces retear risk after arthroscopic rotator cuff repair when stratified by formulation. We further explored the consistency of these effects through pre-specified subgroup and sensitivity analyses and estimated the potential cost implications of adoption using a conservative economic model. By integrating formulation-specific analysis with clinical outcomes and pragmatic economic considerations, this study aims to inform real-world surgical decision-making. We hypothesized that leukocyte-poor PRP would be associated with lower structural retear rates after arthroscopic rotator cuff repair compared with leukocyte-rich PRP or no PRP.

Methods

This review followed the PRISMA 2020 guidelines.[29]

Search Strategy and Study Selection

A systematic search of PubMed and Embase was conducted through July 2025 using combinations of terms including platelet-rich plasma, PRP, rotator cuff, and repair. Eligible studies were comparative clinical investigations of PRP use during arthroscopic RCR that reported imaging-confirmed retear outcomes.

Exclusion criteria were: (1) animal studies; (2) non-PRP biologics; (3) stand-alone PRP injection studies; (4) absence of a control group; (5) no imaging follow-up; and (6) incompatible retear definitions. Specifically, studies were required to define retear as Sugaya grade IV or V[40], or an equivalent full-thickness failure. Trials that grouped Sugaya grades III–V together without stratified reporting were excluded to minimize misclassification risk.

Data Extraction and Risk of Bias

Study characteristics, patient demographics, PRP formulation (leukocyte-poor [LP], leukocyte-rich [LR], platelet-rich fibrin matrix [PRFM], PRP gel, leukocyte PRF), tear size, follow-up duration, and outcomes were extracted into a standardized spreadsheet. Risk of bias was assessed using the ROB2 tool for randomized controlled trials and ROBINS-I for nonrandomized studies.[38,39]

Outcomes

The primary outcome was radiologic retear, defined as structural failure on postoperative imaging. Where Sugaya grading was reported, retear was defined as Sugaya grade IV or V. In studies reporting dichotomous outcomes, retear was defined as a full-thickness defect, consistent with criteria equivalent to Sugaya grade IV. Studies defining retear as partial-thickness failure (e.g., Sugaya grade III) without reporting grade-specific event counts were excluded to maintain consistency in outcome definition. Secondary outcomes included patient-reported function (ASES, Constant, UCLA) and pain (VAS). An exploratory economic analysis estimated the cost implications of PRP adoption.

Statistical Analysis

Dichotomous outcomes were summarized as risk ratios (RRs) with 95% confidence intervals (CIs) and pooled using a Mantel–Haenszel random-effects model with between-study variance (τ^2) estimated by restricted maximum likelihood (REML). Hartung–Knapp adjustment was applied for the overall model; for small-k subgroups (e.g., formulation and tear-size strata), Hartung–Knapp was not applied by design. A continuity correction of 0.5 was used only when any study arm contained zero events. In multi-arm trials with a shared control (e.g., Yao et al.), the control group was proportionally split to avoid double-counting in subgroup analyses. Heterogeneity was assessed using τ^2, Cochran's Q, and I^2 statistics, with prediction intervals reported when available.

Pre-specified subgroup analyses examined:

1. PRP formulation (LP, LR, PRFM, gel, L-PRF),

2. Tear size (medium, large, massive), and

3. Follow-up duration, categorized as short term (≤6 months), midterm (>6–12 months), and long term (>12 months).

Sensitivity analyses included: (1) exclusion of high-risk-of-bias studies; (2) randomized trials only; and (3) exclusion of Auregan et al., the only study rated at critical overall risk of bias, and the three-arm Yao et al. trial. Publication bias was assessed using Egger's regression and trim-and-fill methods.[13,14] Influence diagnostics included leave-one-out analyses to assess the impact of individual studies on pooled estimates. Analyses were performed in R using the *meta* and *metafor* packages.[32]

Economic Analysis

A cost-consequence model was developed from a U.S. payer perspective using a perioperative, episode-of-care time horizon. The model incorporated two primary cost inputs: (1) the cost of revision rotator cuff repair (base case: $5,101 per revision) and (2) the consumable cost of intraoperative platelet-rich plasma (PRP) preparation (base case: $52.27 per case).

Revision costs were derived from average Medicare facility reimbursement rates across ambulatory surgery centers (ASC) and hospital outpatient departments using the CMS Physician Fee Schedule Look-Up Tool (accessed 2025).[9] Per-case PRP setup costs were derived from a published manual PRP preparation protocol.[8] All supplies required for PRP preparation (including needles, syringes, tubes, gloves, forceps, centrifuge, and laminar flow hood) were itemized and priced using contemporary U.S. vendor data (Fisher Scientific, Thomas Scientific,

Amazon Medical). Capital equipment was amortized over a 5-year expected lifespan, while consumables were costed per use, yielding an average per-case preparation cost of $52.27 (range $19.93–$79.84 based on vendor pricing). This costing approach used universally available consumables and amortized equipment, allowing evaluation across both hospital and ambulatory surgery center settings.

Retear risks for leukocyte-poor PRP (LP-PRP) and leukocyte-rich PRP (LR-PRP) were derived from pooled meta-analytic estimates. Absolute risk reduction (ARR) and number needed to treat (NNT) were calculated, and national projections were generated by applying pooled estimates to approximately 300,000 annual rotator cuff repairs in the United States.[18,47] As not all structural failures proceed to revision surgery, revision-cost avoidance estimates were conservatively scaled using a base-case revision probability of 6%, consistent with prospective series summarized in a contemporary narrative review and with large administrative cohorts reporting low rates of subsequent ipsilateral shoulder surgery after arthroscopic rotator cuff repair. [16,24,27]Exploratory sensitivity analyses evaluated higher revision probabilities (up to 12%) to reflect variability across clinical settings and follow-up durations. Indirect costs, quality-adjusted life-years, and non-revision healthcare utilization were excluded from the primary model to avoid introducing additional assumptions and maintain a conservative analytic framework.

Results

Study Characteristics

Twenty-one studies involving 1,279 patients (660 receiving PRP, 619 control) were included, comprising 14 randomized controlled trials and 7 comparative nonrandomized studies [3,4,6,7,10,19–21,23,25,26,30,33–35,37,42,43,48–50] (Fig. 1, PRISMA flow diagram). All trials reported imaging-confirmed retears defined as Sugaya grade IV–V or an equivalent full-thickness failure. Most studies involved medium-to-large tears repaired arthroscopically. Risk of bias was generally low to moderate among RCTs and moderate to serious among nonrandomized studies. Auregan et al. (2019) was the only study rated at critical overall risk of bias.

Primary Outcome — Retear Rate

Across all formulations, intraoperative PRP reduced structural retear risk compared with control (RR 0.74, 95% CI 0.55–0.99) with moderate heterogeneity ($I^2 \approx 29\%$) (Fig. 2).

When stratified by formulation (Fig 3), LP-PRP showed the strongest directional benefit (RR 0.53, 95% CI 0.21–1.31) but with $I^2 = 53.3\%$ driven primarily by *Auregan et al.* Excluding Auregan produced a homogeneous, precise effect (RR 0.37, 95% CI 0.19–0.73; $I^2 = 0\%$) (Suppl. Fig. 1). LR-PRP trended protective but remained nonsignificant (RR 0.76, 95% CI 0.52–1.12; $I^2 = 0\%$). Other constructs (e.g., PRFM, gel) showed no consistent advantage (Suppl. Fig. 1)

Sensitivity Analyses

Sensitivity analyses confirmed the direction and stability of the overall effect. Restricting to randomized controlled trials strengthened the signal (RR 0.64, 95% CI 0.42–0.97; $I^2 = 0.4\%$), while excluding high-risk-of-bias studies yielded a similar trend (RR 0.74, 95% CI 0.49–1.12; I^2

= 0.4%). Removal of the three-arm Yao et al. (2024) trial produced comparable results (RR 0.75, 95% CI 0.57–0.99; I^2 = 0.3%).

Auregan et al. (2019) was the only study at critical overall risk of bias. With Auregan included, the LP-PRP subgroup I^2 was 53.3%. Excluding Auregan reduced I^2 to 0% and narrowed the CI around a stable, stronger effect (RR 0.37, 95% CI 0.19–0.73). Using the observed control event rate of 18.7%, this corresponds to ARR 11.8% and NNT 9 to prevent one retear.

Tear Size and Follow-Up Duration

The clearest and most consistent benefit was observed in medium-sized tears (RR 0.68, 95% CI 0.48–0.96; I^2 = 0.1%; Fig. 4), which represented the largest subgroup across 16 studies (n=895; 466 PRP, 429 control). Protective effects were also seen in large tears (RR 0.80, 95% CI 0.41–1.57; Fig. 4) although with wider confidence intervals given the smaller sample size across 5 studies (n=323; 163 PRP, 160 control). No measurable benefit was found in massive tears, which were assessed in a single study (n=61; 31 PRP, 30 control). Benefit was observed across short-, mid-, and long-term follow-up periods, with no significant time-by-treatment interaction (Suppl. Fig. 2).

Patient-Reported Outcomes

No clinically meaningful improvements were observed in patient-reported outcomes. Pooled analyses of ASES, Constant, and UCLA scores revealed no significant between-group differences, and although VAS pain showed a statistically detectable reduction favoring PRP (MD = -0.1, p = 0.028), the magnitude was well below the minimal clinically important difference (MCID), indicating no true clinical benefit (Fig. 5A–D).[41]

Small-Study Effects and Publication Bias

Egger's regression indicated funnel plot asymmetry (p = 0.017), consistent with small-study effects. Trim-and-fill imputed k_0 = 8 studies; the bias-adjusted estimate attenuated to RR 0.91 (95% CI 0.69–1.19), interpreted cautiously as a sensitivity analysis rather than a corrected effect size (Suppl. Fig. 3–4).

Economic Implications

Using pooled LP-PRP estimates (Fig. 6), application across approximately 300,000 annual U.S. rotator cuff repairs was projected to prevent an estimated 35,343 structural retears. When scaled using the base-case revision probability of 6%, this corresponded to approximately 2,120 avoided revision procedures annually; under exploratory sensitivity scenarios extending revision probability to 12%, up to 4,241 avoided revisions were projected.

Under these assumptions, the modeled break-even total PRP cost per case ranged from approximately $36 at a 6% revision probability to approximately $72 under the exploratory 12% scenario. At the base-case PRP consumable cost ($52.27 per case), the implied break-even revision probability was approximately 9%. When applied nationally, the modeled net cost impact ranged from an estimated $4.9 million deficit under conservative assumptions to an estimated $6.0 million surplus under higher revision-rate scenarios. These projections reflect short-term, episode-of-care economic effects only; long-term societal costs and quality-of-life outcomes were not incorporated into the base model.

Discussion

This meta-analysis demonstrates that intraoperative platelet-rich plasma (PRP) reduces structural failure after arthroscopic rotator cuff repair, with the most consistent and durable effect observed in leukocyte-poor PRP (LP-PRP). In contrast to prior reviews that pooled heterogeneous PRP formulations and yielded conflicting conclusions, our stratified approach shows that the clinical signal depends on formulation. Including the single study at critical overall risk of bias (Auregan et al.) inflated heterogeneity in the LP-PRP subgroup ($I^2 = 53.3\%$), whereas excluding it eliminated heterogeneity ($I^2 = 0\%$) and clarified a precise effect (RR 0.37, 95% CI 0.19–0.73), supporting a formulation-specific effect under lower-bias conditions. LP-PRP demonstrated the most consistent formulation-specific signal, with LR-PRP trending protective but nonsignificant; PRFM and gels showed no consistent advantage. The pattern supports LP-PRP as the leading candidate for structural protection, pending confirmation in larger, formulation-specific trials (Fig. 3). The consistent protective effect observed with LP-PRP suggests that its relevance extends beyond healing biology: preventing revision surgery not only reduces healthcare costs but also spares patients the pain, rehabilitation burden, and prolonged loss of quality of life associated with repeat operations. Taken together, these findings highlight LP-PRP as both a clinically and economically meaningful adjunct, whereas other formulations have not demonstrated the same level of reliability.

Biological Rationale for LP-PRP

The biologic plausibility of LP-PRP is well-supported by preclinical evidence. Tendon-to-bone healing relies on a coordinated interplay between growth factors and immune cell phenotypes. LP-PRP delivers supraphysiologic concentrations of TGF-β, VEGF, EGF, and PDGF, which

promote fibroblast activity, collagen deposition, and angiogenesis.[44,45] Crucially, unlike leukocyte-rich formulations, LP-PRP dampens pro-inflammatory cytokines such as IL-1β, IL-6 and TNF-α, fostering a regenerative rather than inflammatory environment at the tendon–bone interface.[45,46]

Animal models reinforce this mechanism: LP-PRP sustains M2 macrophage predominance and reduces inflammatory signaling, whereas LR-PRP increases cytokine-driven fibrosis.[28,31] Macrophage polarization studies similarly show that M1 phenotypes impede matrix regeneration, while M2 macrophages support angiogenesis and collagen alignment[22]. Excessive TGF-β1, meanwhile, risks promoting scar-dominated healing with mechanically inferior collagen I/III ratios.[1] By shifting the immune response toward M2 predominance, LP-PRP appears to support organized tendon–bone integration rather than fibrotic scar. Collectively, these findings explain why LP-PRP, but not LR-PRP, reliably reduces structural retears: by steering healing toward organized enthesis regeneration rather than fibrotic encapsulation. (Fig. 3).

Clinical Implications

Clinically, LP-PRP was associated with a meaningful reduction in retear risk, corresponding to an absolute risk reduction (ARR) of 11.8% and a number needed to treat (NNT) of 9 to prevent one retear, based on a control event rate of 18.7%. The most pronounced effect was seen in medium-sized tears (Fig. 4), where repair durability remains a challenge. Large tears showed similar directional trends with wider confidence intervals, and massive tears demonstrated no measurable benefit.

Although patient-reported outcomes (ASES, Constant, UCLA, VAS) were not significantly improved (Fig. 5), this aligns with prior studies.[2,11,15,48] PROMs typically improve following any

successful repair but tend to decline over time when retears occur. Prospective cohort studies confirm that structural failure predicts subsequent deterioration in pain and function scores[17]. Our findings suggest LP-PRP acts primarily as a structural safeguard—reducing failure risk without accelerating short-term symptomatic recovery. This interpretation is consistent with both the biologic mechanism and long-term clinical trajectory of retear-associated decline.

Economic Relevance

Revision rotator cuff repair is resource-intensive, costly, and disruptive to patient recovery, making even modest reductions in retear risk clinically and economically meaningful. Using a conservative, episode-of-care cost-consequence framework grounded in Medicare reimbursement data, the present analysis demonstrates that the economic impact of leukocyte-poor PRP augmentation is highly sensitive to the proportion of structural failures that proceed to revision surgery. When revision probabilities ranging from 6% to 12% were incorporated, LP-PRP was associated with modeled outcomes spanning from modest net cost deficits to modest net cost savings at the national level, with near cost-neutrality at intermediate values.

These findings underscore that the economic value of LP-PRP is conditional rather than uniform. Importantly, the break-even total PRP cost per case fell within a relatively narrow range under plausible revision probabilities, suggesting that low-cost preparation strategies may achieve cost neutrality. Because commercial-kit-based systems often have higher per-case costs than manual preparation, the break-even thresholds reported here can be interpreted as cost ceilings above which LP-PRP is unlikely to be cost-neutral under the modeled revision probabilities. In settings where PRP-related costs are not routinely reimbursed, financial responsibility may be transferred to patients, shifting the economic evaluation from a payer-centered framework toward shared

physician–patient decision-making. Under these circumstances, even when structural benefit is observed, the value of PRP augmentation may depend on individual patient preferences, financial capacity, and treatment priorities. Accordingly, the present economic results should be interpreted as illustrative of potential payer-side impact under defined assumptions, rather than as evidence of universal cost savings, and as highlighting the importance of cost-reduction strategies in facilitating real-world adoption.

Strengths and Limitations

This review has several notable strengths. Chief among these is its formulation-specific approach, which distinguishes leukocyte-poor from leukocyte-rich PRP rather than pooling heterogeneous biologic preparations as a single intervention. Structural failure was objectively defined using postoperative imaging, with outcomes harmonized to full-thickness retear equivalent to Sugaya grade IV. All analyses were conducted using standardized risk-of-bias assessment tools and pre-specified subgroup and sensitivity frameworks. The analytic workflow and figures were generated using fully reproducible code, enhancing transparency and reproducibility. Findings remained consistent after exclusion of the single critically biased trial, supporting the robustness of the observed structural effect. In addition, the pragmatic economic model incorporated real-world cost inputs and readily implementable manual preparation methods, allowing evaluation across both hospital and ambulatory surgical center settings.

Several limitations warrant consideration. PRP preparation protocols and reporting methods varied across included studies, and despite outcome harmonization, definitions of retear were not fully standardized across trials. Subgroup analyses were limited by relatively small sample sizes, and a number of nonrandomized studies carried moderate to serious risk of bias. Publication bias

cannot be excluded; funnel-plot asymmetry suggested possible small-study effects, and bias-adjusted estimates should be interpreted as exploratory. Moreover, most trials lacked objective strength testing within age-adjusted Constant scores, limiting conclusions regarding functional recovery. Finally, the economic analysis captured short-term, episode-of-care healthcare expenditures only and did not incorporate indirect costs, long-term societal impact, or quality-of-life outcomes.

Conclusion

Intraoperative leukocyte-poor platelet-rich plasma (LP-PRP) appears to reduce retear risk after arthroscopic rotator cuff repair, with consistent benefits across study designs that strengthen when high-risk trials are excluded. Excluding the single critically-biased study reduced heterogeneity from 53.3% to 0%, clarifying a precise, formulation-specific effect. By linking biologic plausibility with structural protection and demonstrating favorable cost projections under conservative assumptions, this meta-analysis offers a formulation-specific framework to inform clinical adoption. LP-PRP represents a feasible, low-cost adjunct that improves repair durability without altering short-term recovery or patient-reported outcomes—making it both a biologically rational and economically practical strategy in modern shoulder surgery. Taken together, these results position LP-PRP as a formulation-specific adjunct worthy of consideration in optimizing RCR outcomes at scale.

Acknowledgments

ChatGPT (OpenAI, San Francisco, CA; GPT-5) was used under author supervision to assist with R code organization, syntax corrections, and minor language refinement. All statistical analyses, results, and interpretations were independently verified by the authors, who take full responsibility for the accuracy and integrity of the work.

References

1. Abdalla G, Pendegrass CJ. Biological approaches to the repair and regeneration of the rotator cuff tendon-bone enthesis: a literature review. Front Bioeng Biotechnol. 2023;11:1176113. doi:10.3389/fbioe.2023.1176113

2. Ahmad Z, Ang S, Rushton N, Harvey A, Akhtar K, Dawson-Bowling S, et al. Platelet-Rich Plasma Augmentation of Arthroscopic Rotator Cuff Repair Lowers Retear Rates and Improves Short-Term Postoperative Functional Outcome Scores: A Systematic Review of Meta-Analyses. Arthrosc. Sports Med. Rehabil. 2022 Apr;4(2):e823–e833. doi:10.1016/j.asmr.2021.12.012

3. Aurégan J-C, Klouche S, Levy B, Bauer T, Rousselin B, Ferrand M, et al. Autologous Conditioned Plasma for tendon healing following arthroscopic rotator cuff repair. Prospective comparative assessment with magnetic resonance arthrography at 6 months' follow-up. Orthop. Traumatol. Surg. Res. 2019 Apr;105(2):245–249. doi:10.1016/j.otsr.2019.01.003

4. Barber FA, Hrnack SA, Snyder SJ, Hapa O. Rotator Cuff Repair Healing Influenced by Platelet-Rich Plasma Construct Augmentation. Arthrosc. J. Arthrosc. Relat. Surg. 2011 Aug;27(8):1029–1035. doi:10.1016/j.arthro.2011.06.010

5. Barr J, Stern M, Hunter K, Gentile P, Clinton C. Analyzing Disparities in Platelet-Rich Plasma Preinjection Protocols for Musculoskeletal Injuries. Clin J Sport Med. 2025. Epub ahead of print. doi:10.1097/JSM.0000000000001384

6. Bergeson AG, Tashjian RZ, Greis PE, Crim J, Stoddard GJ, Burks RT. Effects of Platelet-Rich Fibrin Matrix on Repair Integrity of At-Risk Rotator Cuff Tears. Am. J. Sports Med. 2012 Feb;40(2):286–293. doi:10.1177/0363546511424402

7. Castricini R, Longo UG, De Benedetto M, Panfoli N, Pirani P, Zini R, et al. Platelet-Rich Plasma Augmentation for Arthroscopic Rotator Cuff Repair: A Randomized Controlled Trial. Am. J. Sports Med. 2011 Feb;39(2):258–265. doi:10.1177/0363546510390780

8. Castro RLBD, Antonio BP, Manoel FGDOM. Is the manual preparation of platelet rich plasma safe? Res. Soc. Dev. 2022 July 21;11(10):e19111032270. doi:10.33448/rsd-v11i10.32270

9. Centers for Medicare & Medicaid Services. Medicare Procedure Price Lookup [Internet]. Medicare.gov. 2025 [cited 2025 July 30];Available from: https://www.medicare.gov/procedure-price-lookup/

10. Charousset C, Zaoui A, Bellaïche L, Piterman M. Does Autologous Leukocyte-Platelet–Rich Plasma Improve Tendon Healing in Arthroscopic Repair of Large or Massive Rotator Cuff Tears? Arthrosc. J. Arthrosc. Relat. Surg. 2014 Apr;30(4):428–435. doi:10.1016/j.arthro.2013.12.018

11. Chen X, Jones IA, Togashi R, Park C, Vangsness CT. Use of Platelet-Rich Plasma for the Improvement of Pain and Function in Rotator Cuff Tears: A Systematic Review and Meta-analysis With Bias Assessment. Am. J. Sports Med. 2020 July;48(8):2028–2041. doi:10.1177/0363546519881423

12. Dohan Ehrenfest DM, Rasmusson L, Albrektsson T. Classification of platelet concentrates: from pure platelet-rich plasma (P-PRP) to leucocyte- and platelet-rich fibrin (L-PRF). Trends Biotechnol. 2009 Mar;27(3):158–167. doi:10.1016/j.tibtech.2008.11.009

13. Duval S, Tweedie R. Trim and Fill: A Simple Funnel-Plot–Based Method of Testing and Adjusting for Publication Bias in Meta-Analysis. Biometrics. 2000 June;56(2):455–463. doi:10.1111/j.0006-341x.2000.00455.x

14. Egger M, Smith GD, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ. 1997 Sept 13;315(7109):629–634. doi:10.1136/bmj.315.7109.629

15. Flury M, Rickenbacher D, Schwyzer H-K, Jung C, Schneider MM, Stahnke K, et al. Does Pure Platelet-Rich Plasma Affect Postoperative Clinical Outcomes After Arthroscopic Rotator Cuff Repair?: A Randomized Controlled Trial. Am. J. Sports Med. 2016 Aug;44(8):2136–2146. doi:10.1177/0363546516645518

16. Hackl M, Flury M, Kolling C, Nebelung W, Krauss CA, Kraemer NA, et al. Results of Arthroscopic Revision Rotator Cuff Repair for Failed Open or Arthroscopic Repair: A Prospective Multicenter Study on 100 Cases. Am. J. Sports Med. 2022 July;50(8):2203–2210. doi:10.1177/03635465221097410

17. Haque A, Pal Singh H. Does structural integrity following rotator cuff repair affect functional outcomes and pain scores? A meta-analysis. Shoulder Elb. 2018 July;10(3):163–169. doi:10.1177/1758573217731548

18. Jain NB, Higgins LD, Losina E, Collins J, Blazar PE, Katz JN. Epidemiology of musculoskeletal upper extremity ambulatory surgery in the United States. BMC Musculoskelet. Disord. 2014 Dec;15(1):4. doi:10.1186/1471-2474-15-4

19. Jo CH, Kim JE, Yoon KS, Lee JH, Kang SB, Lee JH, et al. Does Platelet-Rich Plasma Accelerate Recovery After Rotator Cuff Repair? A Prospective Cohort Study. Am. J. Sports Med. 2011 Oct;39(10):2082–2090. doi:10.1177/0363546511413454

20. Jo CH, Shin JS, Lee YG, Shin WH, Kim H, Lee SY, et al. Platelet-Rich Plasma for Arthroscopic Repair of Large to Massive Rotator Cuff Tears: A Randomized, Single-Blind, Parallel-Group Trial. Am. J. Sports Med. 2013 Oct;41(10):2240–2248. doi:10.1177/0363546513497925

21. Jo CH, Shin JS, Shin WH, Lee SY, Yoon KS, Shin S. Platelet-Rich Plasma for Arthroscopic Repair of Medium to Large Rotator Cuff Tears: A Randomized Controlled Trial. Am. J. Sports Med. 2015 Sept;43(9):2102–2110. doi:10.1177/0363546515587081

22. Lana JF, Huber SC, Purita J, Tambeli CH, Santos GS, Paulus C, et al. Leukocyte-rich PRP versus leukocyte-poor PRP - The role of monocyte/macrophage function in the healing cascade. J. Clin. Orthop. Trauma. 2019 Oct;10:S7–S12. doi:10.1016/j.jcot.2019.05.008

23. Li M, Wang K, Zhang H, Fang C, Liu H, Zhang Y. Clinical Evaluations of Intraoperative Injection of Platelet-Rich Plasma in Arthroscopic Single-Row Rotator Cuff Repair at 2-Year Follow-Up. Biomed Res Int. 2021;2021:6675097. doi:10.1155/2021/6675097

24. Mahure SA, Mollon B, Shamah SD, Zuckerman JD, Kwon YW, Rokito AS. Reoperation rate following isolated arthroscopic rotator cuff repair. J Shoulder Elbow Surg. 2016;25(10):e322–e323. doi:10.1016/j.jse.2016.07.045

25. Malavolta EA, Gracitelli MEC, Assunção JH, Ferreira Neto AA, Bordalo-Rodrigues M, De Camargo OP. Clinical and Structural Evaluations of Rotator Cuff Repair With and Without Added Platelet-Rich Plasma at 5-Year Follow-up: A Prospective Randomized Study. Am. J. Sports Med. 2018 Nov;46(13):3134–3141. doi:10.1177/0363546518795895

26. Martinelli D, Fornara P, Stecco A, Grassi FA. Does Intraoperative Platelet-rich Plasma Improve Clinical and Structural Outcomes after Arthroscopic Repair of Isolated Tears of the Supraspinatus Tendon? Indian J. Orthop. 2019 Feb;53(1):77–81. doi:10.4103/ortho.IJOrtho_35_17

27. Mirzayan R, Weber AE, Petrigliano FA, Chahla J. Rationale for Biologic Augmentation of Rotator Cuff Repairs. J. Am. Acad. Orthop. Surg. 2019 July 1;27(13):468–478. doi:10.5435/JAAOS-D-18-00281

28. Nishio H, Saita Y, Kobayashi Y, Takaku T, Fukusato S, Uchino S, et al. Platelet-rich plasma promotes recruitment of macrophages in the process of tendon healing. Regen. Ther. 2020 June;14:262–270. doi:10.1016/j.reth.2020.03.009

29. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Syst Rev. 2021;10(1):89. doi:10.1186/s13643-021-01626-4

30. Pandey V, Bandi A, Madi S, Agarwal L, Acharya KKV, Maddukuri S, et al. Does application of moderately concentrated platelet-rich plasma improve clinical and structural outcome after arthroscopic repair of medium-sized to large rotator cuff tear? A randomized controlled trial. J. Shoulder Elbow Surg. 2016 Aug;25(8):1312–1322. doi:10.1016/j.jse.2016.01.036

31. Peng Y, Xu W, Li X, Shangguan H, Diao L, Ma H, et al. Effects of leukocyte-rich platelet-rich plasma and leukocyte-poor platelet-rich plasma on the healing of bone-tendon interface of rotator cuff in a mice model. Platelets. 2022;33(7):1075–1082. doi:10.1080/09537104.2022.2044462

32. R Core Team. R: A Language and Environment for Statistical Computing [Internet]. 2024;Available from: https://www.R-project.org/

33. Randelli P, Arrigoni P, Ragone V, Aliprandi A, Cabitza P. Platelet rich plasma in arthroscopic rotator cuff repair: a prospective RCT study, 2-year follow-up. J. Shoulder Elbow Surg. 2011 June;20(4):518–528. doi:10.1016/j.jse.2011.02.008

34. Rodeo SA, Delos D, Williams RJ, Adler RS, Pearle A, Warren RF. The Effect of Platelet-Rich Fibrin Matrix on Rotator Cuff Tendon Healing: A Prospective, Randomized Clinical Study. Am. J. Sports Med. 2012 June;40(6):1234–1241. doi:10.1177/0363546512442924

35. Rossi LA, Gorodischer TD, Camino P, Brandariz RN, Tanoira I, Piuzzi NS, et al. Leukocyte-Poor Platelet-Rich Plasma as an Adjuvant to Arthroscopic Rotator Cuff Repair Reduces the Retear Rate But Does Not Improve Functional Outcomes: A Double-Blind Randomized

Controlled Trial. Am. J. Sports Med. 2024 May;52(6):1403–1410. doi:10.1177/03635465241239062

36. Rossi LA, Murray IR, Chu CR, Muschler GF, Rodeo SA, Piuzzi NS. Classification systems for platelet-rich plasma. Bone Jt. J. 2019 Aug;101-B(8):891–896. doi:10.1302/0301-620x.101b8.bjj-2019-0037.r1

37. Snow M, Hussain F, Pagkalos J, Kowalski T, Green M, Massoud S, et al. The Effect of Delayed Injection of Leukocyte-Rich Platelet-Rich Plasma Following Rotator Cuff Repair on Patient Function: A Randomized Double-Blind Controlled Trial. Arthrosc. J. Arthrosc. Relat. Surg. 2020 Mar;36(3):648–657. doi:10.1016/j.arthro.2019.09.026

38. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016 Oct 12;i4919. doi:10.1136/bmj.i4919

39. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ. 2019 Aug 28;l4898. doi:10.1136/bmj.l4898

40. Sugaya H, Maeda K, Matsuki K, Moriishi J. Functional and Structural Outcome After Arthroscopic Full-Thickness Rotator Cuff Repair: Single-Row Versus Dual-Row Fixation. Arthrosc. J. Arthrosc. Relat. Surg. 2005 Nov;21(11):1307–1316. doi:10.1016/j.arthro.2005.08.011

41. Tashjian RZ, Shin J, Broschinsky K, Yeh C-C, Martin B, Chalmers PN, et al. Minimal clinically important differences in the American Shoulder and Elbow Surgeons, Simple

Shoulder Test, and visual analog scale pain scores after arthroscopic rotator cuff repair. J. Shoulder Elbow Surg. 2020 July;29(7):1406–1411. doi:10.1016/j.jse.2019.11.018

42. Walsh MR, Nelson BJ, Braman JP, Yonke B, Obermeier M, Raja A, et al. Platelet-rich plasma in fibrin matrix to augment rotator cuff repair: a prospective, single-blinded, randomized study with 2-year follow-up. J. Shoulder Elbow Surg. 2018 Sept;27(9):1553–1563. doi:10.1016/j.jse.2018.05.003

43. Weber SC, Kauffman JI, Parise C, Weber SJ, Katz SD. Platelet-Rich Fibrin Matrix in the Management of Arthroscopic Repair of the Rotator Cuff: A Prospective, Randomized, Double-Blinded Study. Am. J. Sports Med. 2013 Feb;41(2):263–270. doi:10.1177/0363546512467621

44. Wen Y-H, Lin W-Y, Lin C-J, Sun Y-C, Chang P-Y, Wang H-Y, et al. Sustained or higher levels of growth factors in platelet-rich plasma during 7-day storage. Clin. Chim. Acta. 2018 Aug;483:89–93. doi:10.1016/j.cca.2018.04.027

45. Xu Z, Yin W, Zhang Y, Qi X, Chen Y, Xie X, et al. Comparative evaluation of leukocyte- and platelet-rich plasma and pure platelet-rich plasma for cartilage regeneration. Sci. Rep. 2017 Mar 7;7(1):43301. doi:10.1038/srep43301

46. Yan R, Gu Y, Ran J, Hu Y, Zheng Z, Zeng M, et al. Intratendon Delivery of Leukocyte-Poor Platelet-Rich Plasma Improves Healing Compared With Leukocyte-Rich Platelet-Rich Plasma in a Rabbit Achilles Tendinopathy Model. Am. J. Sports Med. 2017 July;45(8):1909–1920. doi:10.1177/0363546517694357

47. Yanik EL, Chamberlain AM, Keener JD. Trends in rotator cuff repair rates and comorbidity burden among commercially insured patients younger than the age of 65 years, United States 2007-2016. JSES Rev. Rep. Tech. 2021 Nov;1(4):309–316. doi:10.1016/j.xrrt.2021.06.009

48. Yao L, Pang L, Zhang C, Yang S, Wang J, Li Y, et al. Platelet-Rich Plasma for Arthroscopic Rotator Cuff Repair: A 3-Arm Randomized Controlled Trial. Am. J. Sports Med. 2024 Dec;52(14):3495–3504. doi:10.1177/03635465241283964

49. Zhang Z, Wang Y, Sun J. The effect of platelet-rich plasma on arthroscopic double-row rotator cuff repair: a clinical study with 12-month follow-up. *Acta Orthop Traumatol Turc.* 2016;50(2):191–197. doi:10.3944/AOTT.2015.15.0113

50. Zumstein MA, Rumian A, Thélu CÉ, Lesbats V, O'Shea K, Schaer M, et al. SECEC Research Grant 2008 II: Use of platelet- and leucocyte-rich fibrin (L-PRF) does not affect late rotator cuff tendon healing: a prospective randomized controlled study. J. Shoulder Elbow Surg. 2016 Jan;25(1):2–11. doi:10.1016/j.jse.2015.09.018

514 **Figure Legends**

515

516 Figure 1. PRISMA flow diagram of study selection

517 Caption: PRISMA 2020 diagram showing study identification, screening, eligibility, and
518 inclusion. Of 396 records, 336 were screened after duplicates; 35 full texts were assessed, and 21
519 studies were included (one with two PRP arms analyzed separately). Reasons for exclusion at
520 full text: overlapping population (n=1), incompatible outcomes (n=7), no postoperative imaging
521 (n=1), irrelevant intervention (n=1), and intervention timing outside the prespecified window
522 (n=3).

523 *PRP, platelet-rich plasma.*

524

525 Figure 2. Overall retear after arthroscopic rotator cuff repair: PRP vs control

526 Forest plot of imaging-confirmed retears comparing PRP with control. Effects are risk ratios
527 (RR, log scale) pooled with a random-effects model (REML; Hartung–Knapp). Squares show
528 study estimates (size ∝ weight), horizontal lines indicate 95% CIs, and the diamond is the pooled
529 effect. PRP reduced retear risk (RR 0.74, 95% CI 0.55–0.99) with low–moderate heterogeneity
530 (I^2 = 28.8%).

531 *PRP, platelet-rich plasma; RR, risk ratio; CI, confidence interval.*

532

533 Figure 3. Retear risk by PRP formulation

534 Caption: Forest plot of subgroup analyses by PRP formulation. Leukocyte-poor PRP (LP-PRP)
535 showed the clearest and most precise reduction (RR 0.37, 95% CI 0.19–0.73); excluding the
536 single critically biased study (*Auregan* 2019) reduced LP-PRP heterogeneity from 53.3% to

0.0%, clarifying the formulation-specific signal. Leukocyte-rich PRP (LR-PRP) trended protective but was not significant (RR 0.76, 95% CI 0.52–1.12); PRFM/PRP matrix showed no consistent advantage, while PRP gel favored PRP (RR 0.42, 95% CI 0.22–0.82). Diamonds indicate random-effects pooled estimates for each subgroup; the test for subgroup differences was not significant ($\chi^2 = 7.76$, df = 4, p = 0.100).

LP-PRP, leukocyte-poor PRP; LR-PRP, leukocyte-rich PRP; PRFM, platelet-rich fibrin matrix; RR, risk ratio; CI, confidence interval.

Figure 4. Retear risk stratified by tear size

Caption: Forest plot of imaging-confirmed retears after arthroscopic rotator cuff repair, grouped by baseline tear size. Medium tears showed a significant reduction with PRP (RR 0.68, 95% CI 0.48–0.96), whereas large (RR 0.80, 95% CI 0.41–1.57) and massive tears (RR 0.89, 95% CI 0.46–1.69) were not significant. Diamonds indicate random-effects pooled estimates within each subgroup; the test for subgroup differences was not significant ($\chi^2 = 0.62$, df = 2, p = 0.730).

PRP, platelet-rich plasma; RR, risk ratio; CI, confidence interval.

Figure 5A-D. Patient-reported outcomes following PRP augmentation during rotator cuff repair

Forest plots of pooled mean differences (MD) comparing PRP versus control for (A) Constant-Murley score (MD 0.7, 95% CI –0.2 to 1.6; p = .112); (B) ASES score (MD 1.5, 95% CI –1.7 to 4.7; p = .363); (C) UCLA Shoulder Rating Scale (MD 0.3, 95% CI 0.0 to 0.6; p = .439); and (D) Visual Analog Scale (VAS) for pain (MD –0.1, 95% CI –0.2 to –0.0; p = .028). All outcomes were pooled using random-effects models (REML; Hartung–Knapp confidence intervals). PRP augmentation did not result in clinically meaningful improvement in patient-reported outcomes.

Although small statistically significant differences were observed for UCLA score and VAS pain, effect sizes were below established minimal clinically important difference thresholds and are unlikely to be clinically meaningful. Squares represent study weights, and diamonds indicate pooled effects.

Figure 6. Cost-consequence schematic for LP-PRP augmentation during arthroscopic rotator cuff repair.

Decision-analytic flow diagram showing the modeled structural retear reduction with leukocyte-poor platelet-rich plasma (LP-PRP) versus standard repair and the downstream economic consequences when only a fraction of structural failures proceed to revision surgery. Using a control structural retear rate of 18.7% and an LP-PRP structural retear rate of 6.9% (ARR 11.8%; NNT = 9), the model estimates cost-neutral (break-even) total PRP cost thresholds and net cost impact per repair and nationally under a base-case revision probability of 6% and scenario analyses at 9% and 12%. Model inputs (including revision cost, PRP preparation/consumable cost, and unit-cost assumptions) are provided in Supplementary Table 1. Net cost impact values are presented at a PRP consumable cost of $52.27 per case and assume 300,000 rotator cuff repairs performed annually in the United States.

Supplemental Figure S1. Retear risk by PRP formulation (Auregan included)

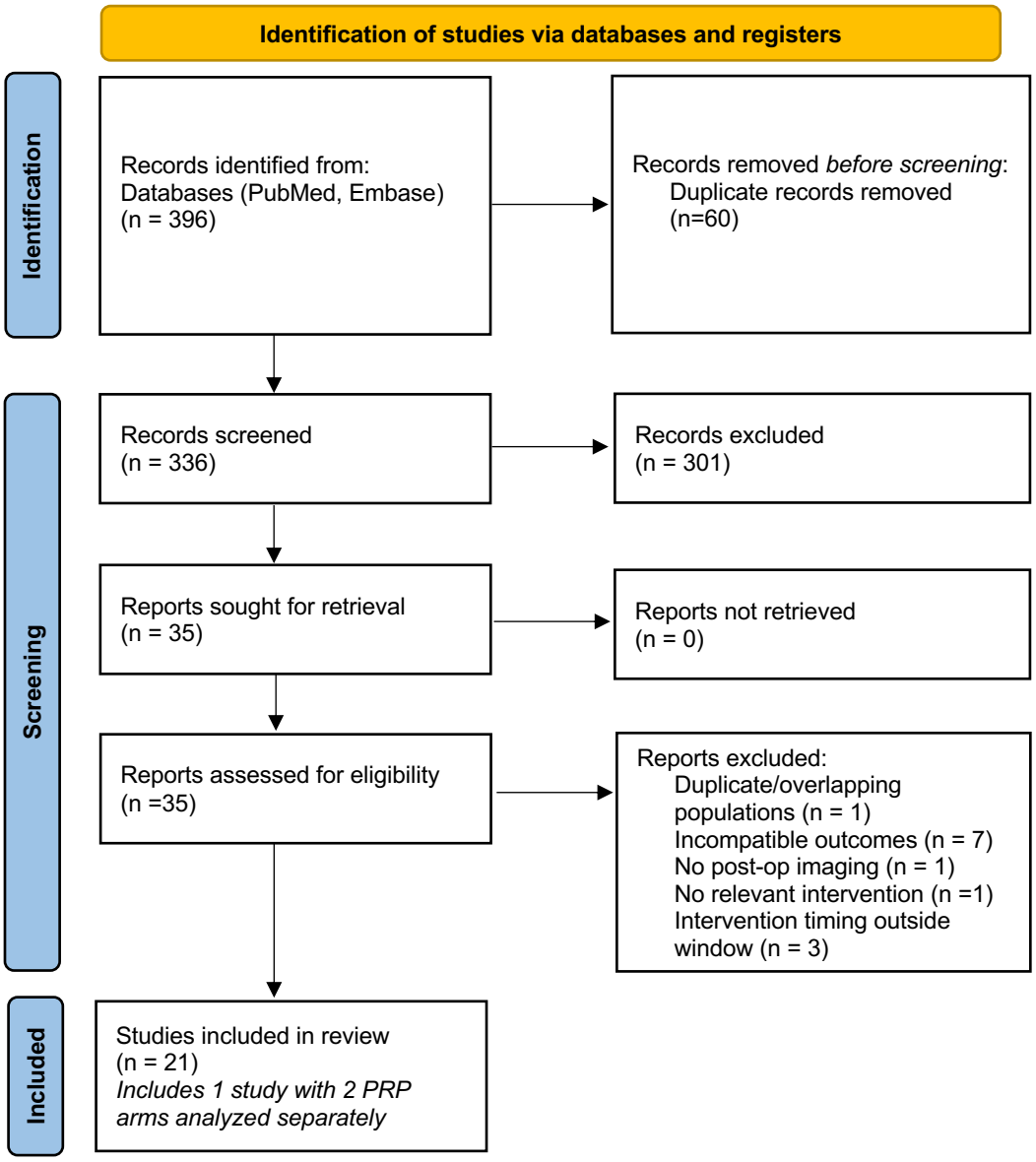
Caption: Forest plot of subgroup analyses by formulation with the critically biased trial by Auregan et al., 2019 retained. LP-PRP shows a nonsignificant trend toward benefit (RR 0.53, 95% CI 0.21–1.31) with higher heterogeneity ($I^2 \approx 53\%$) versus the 0% seen when Auregan is

582 excluded in the main text. LR-PRP is nonsignificant (RR 0.76, 95% CI 0.52–1.12). PRFM/PRP
583 matrix shows no advantage (RR 0.95, 95% CI 0.55–1.66), PRP gel favors PRP (RR 0.42, 95%
584 CI 0.22–0.82), and L-PRF favors PRP (RR 0.71, 95% CI 0.53–0.95). Diamonds denote random-
585 effects pooled estimates; study weights are inverse-variance.
586
587 Supplemental Figure S2. Retear risk by follow-up duration.
588 Caption: Subgroup forest plot stratified by follow-up duration. Effects were directionally
589 consistent across time windows: short-term (≤6 mo) RR 0.78 [0.51–1.20], mid-term (>6–12 mo)
590 RR 0.78 [0.50–1.22], long-term (>12 mo) RR 0.42 [0.15–1.21], and extended-term (latest
591 follow-up in two studies) RR 0.33 [0.01–7.75]. Test for subgroup differences: $\chi^2 = 1.46$, df = 3, p
592 = 0.690 (no evidence of effect modification by time).
593
594 Supplemental Figure S3. Funnel plot for publication bias in retear outcomes (unadjusted)
595 Caption: Funnel plot (SE vs. log RR) for all studies. Visual asymmetry suggests small study
596 effects; Egger's regression p = 0.017. Dashed vertical line marks the null; dotted lines outline
597 pseudo 95% CIs.
598
599 Supplemental Figure S4. Trim-and-fill funnel plot for retear outcomes (imputed studies in white)
600 Caption: Trim-and-fill analysis imputing k_0=8 potentially missing studies (open circles). The
601 bias-adjusted pooled effect attenuates to RR 0.91 (95% CI 0.69–1.19). Interpreted as a sensitivity
602 analysis rather than a corrected estimate.
603

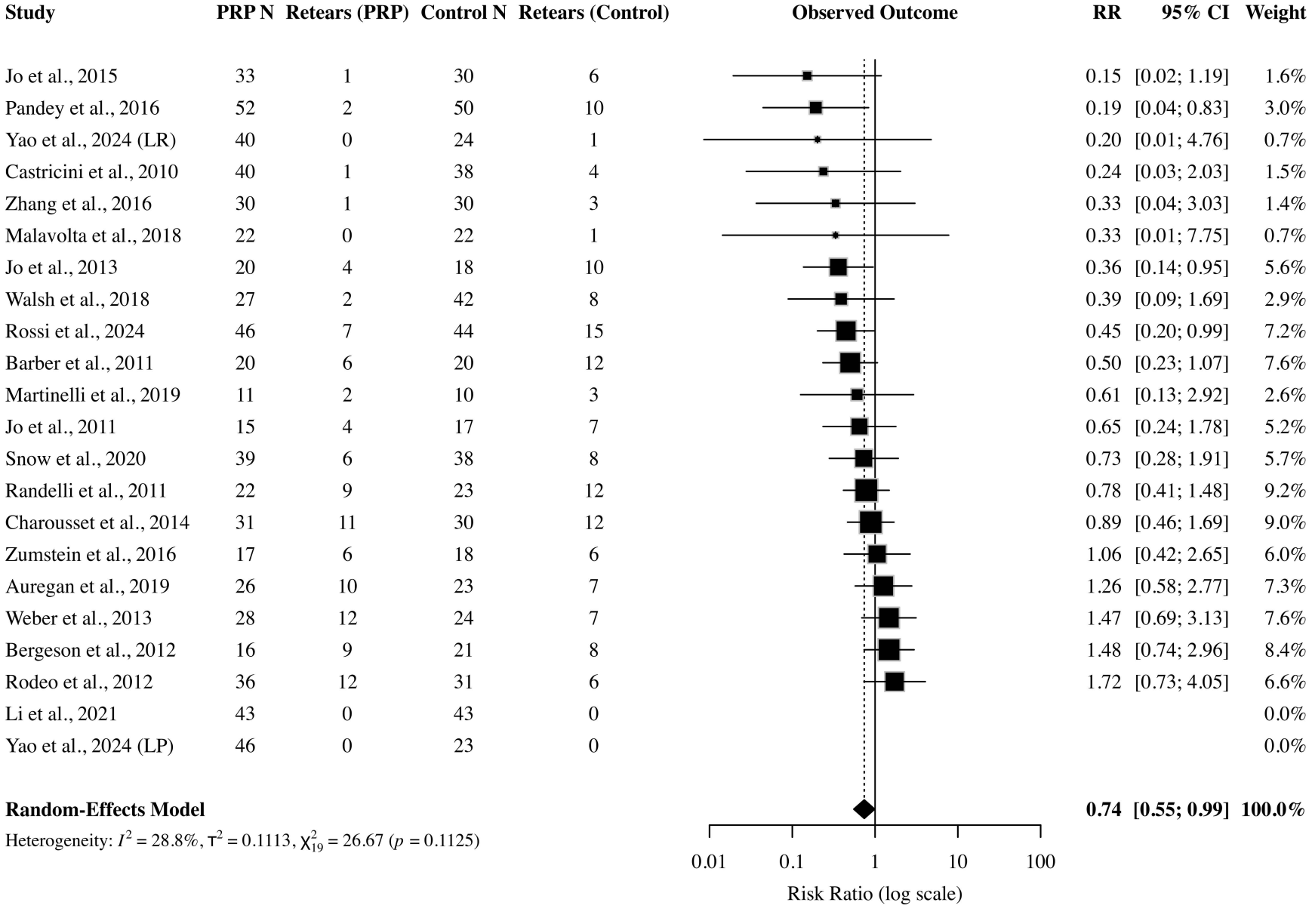
Supplemental Table 1. Per-patient supply and equipment costs for manual LP-PRP preparation (U.S. 2025 dollars)

Caption: Itemized consumables and amortized capital used to prepare leukocyte-poor PRP intra-operatively. Quantities reflect a single case; costs are shown as lowest / average / highest observed across common U.S. vendors. Capital items listed as “Fixed (amortized)” contribute <$0.01/patient under 5-year straight-line amortization. The summed average total cost per patient is $52.27 (range $19.93–$79.84).

Abbreviations: ACD-A, anticoagulant citrate dextrose solution A; PRP, platelet-rich plasma.

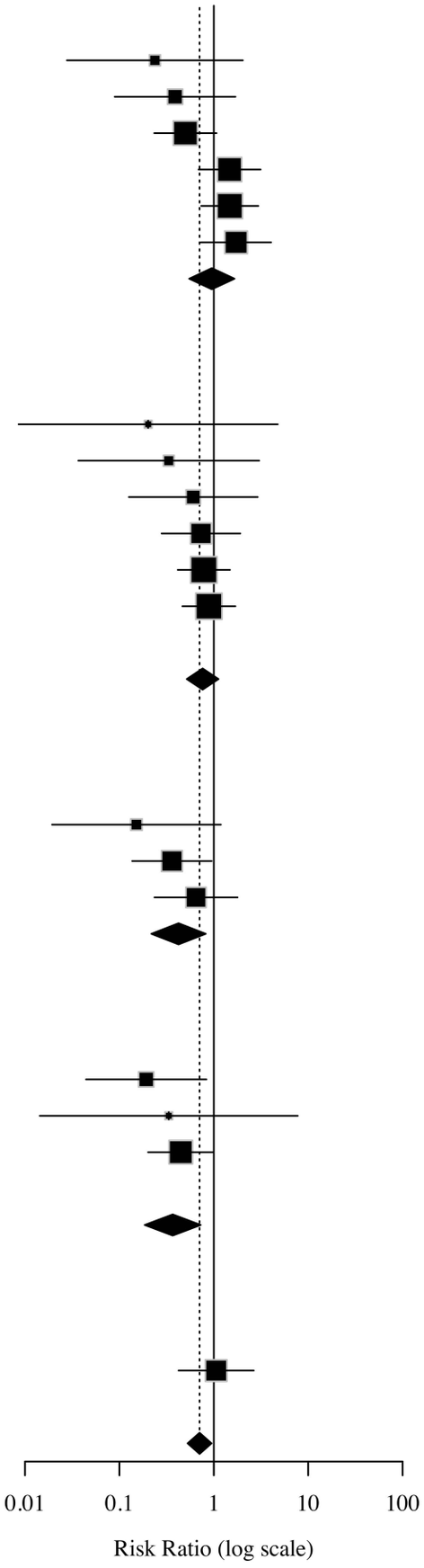


Source: Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.


Study
PRP N
Retears (PRP)
Control N
Retears (Control)
Observed Outcome
RR
95% CI
Weight
Jo et al., 2015 33 1 30 6 0.15 [0.02; 1.19] 1.6%
Pandey et al., 2016 52 2 50 10 0.19 [0.04; 0.83] 3.0%
Yao et al., 2024 (LR) 40 0 24 1 0.20 [0.01; 4.76] 0.7%
Castricini et al., 2010 40 1 38 4 0.24 [0.03; 2.03] 1.5%
Zhang et al., 2016 30 1 30 3 0.33 [0.04; 3.03] 1.4%
Malavolta et al., 2018 22 0 22 1 0.33 [0.01; 7.75] 0.7%
Jo et al., 2013 20 4 18 10 0.36 [0.14; 0.95] 5.6%
Walsh et al., 2018 27 2 42 8 0.39 [0.09; 1.69] 2.9%
Rossi et al., 2024 46 7 44 15 0.45 [0.20; 0.99] 7.2%
Barber et al., 2011 20 6 20 12 0.50 [0.23; 1.07] 7.6%
Martinelli et al., 2019 11 2 10 3 0.61 [0.13; 2.92] 2.6%
Jo et al., 2011 15 4 17 7 0.65 [0.24; 1.78] 5.2%
Snow et al., 2020 39 6 38 8 0.73 [0.28; 1.91] 5.7%
Randelli et al., 2011 22 9 23 12 0.78 [0.41; 1.48] 9.2%
Charousset et al., 2014 31 11 30 12 0.89 [0.46; 1.69] 9.0%
Zumstein et al., 2016 17 6 18 6 1.06 [0.42; 2.65] 6.0%
Auregan et al., 2019 26 10 23 7 1.26 [0.58; 2.77] 7.3%
Weber et al., 2013 28 12 24 7 1.47 [0.69; 3.13] 7.6%
Bergeson et al., 2012 16 9 21 8 1.48 [0.74; 2.96] 8.4%
Rodeo et al., 2012 36 12 31 6 1.72 [0.73; 4.05] 6.6%
Li et al., 2021 43 0 43 0 0.0%
Yao et al., 2024 (LP) 46 0 23 0 0.0%
Random-Effects Model 0.74 [0.55; 0.99] 100.0%
Heterogeneity: $I^2 = 28.8\%$, $\tau^2 = 0.1113$, $\chi^2_{19} = 26.67$ ($p = 0.1125$)
0.01
0.1
1
10
100
Risk Ratio (log scale)

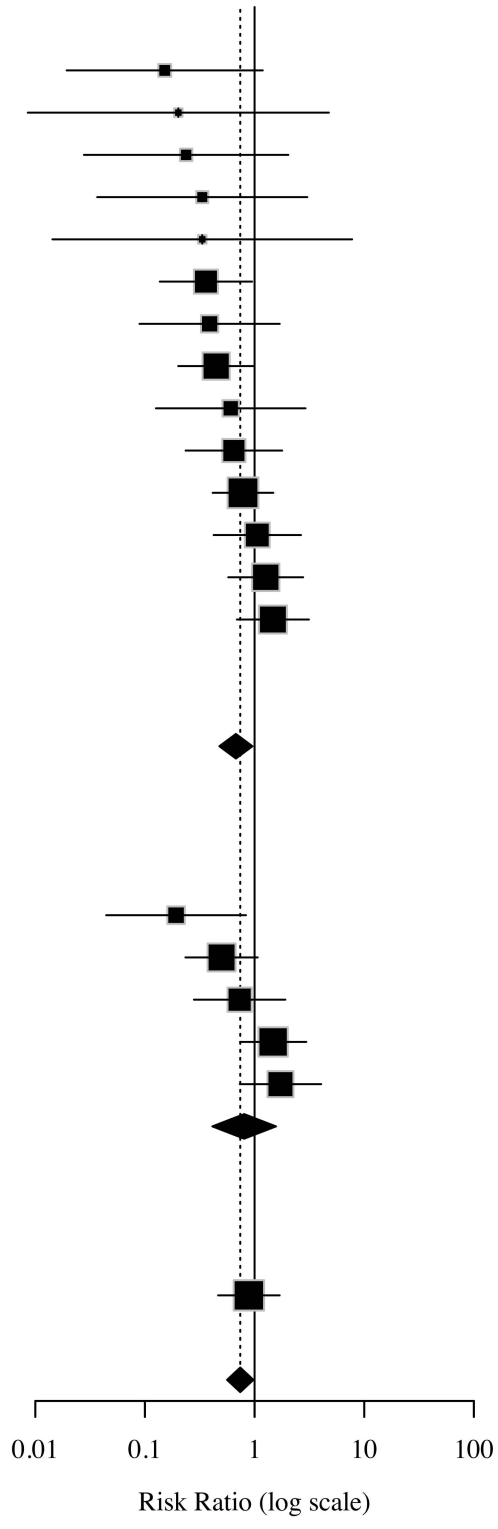
Study	PRP N	Retears (PRP)	Control N	Retears (Control)	RR	95% CI	Weight
PRFM/PRPFM							
Castricini et al., 2010	40	1	38	4	0.24	[0.03; 2.03]	1.7%
Walsh et al., 2018	27	2	42	8	0.39	[0.09; 1.69]	3.2%
Barber et al., 2011	20	6	20	12	0.50	[0.23; 1.07]	8.2%
Weber et al., 2013	28	12	24	7	1.47	[0.69; 3.13]	8.2%
Bergeson et al., 2012	16	9	21	8	1.48	[0.74; 2.96]	9.0%
Rodeo et al., 2012	36	12	31	6	1.72	[0.73; 4.05]	7.1%
Random-Effects Model (by subgroup)					**0.95**	**[0.55; 1.66]**	**37.3%**
LR PRP							
Yao et al., 2024 (LR)	40	0	24	1	0.20	[0.01; 4.76]	0.8%
Zhang et al., 2016	30	1	30	3	0.33	[0.04; 3.03]	1.6%
Martinelli et al., 2019	11	2	10	3	0.61	[0.13; 2.92]	2.9%
Snow et al., 2020	39	6	38	8	0.73	[0.28; 1.91]	6.1%
Randelli et al., 2011	22	9	23	12	0.78	[0.41; 1.48]	9.8%
Charousset et al., 2014	31	11	30	12	0.89	[0.46; 1.69]	9.6%
Li et al., 2021	43	0	43	0			0.0%
Random-Effects Model (by subgroup)					**0.76**	**[0.52; 1.12]**	**30.8%**
PRP Gel							
Jo et al., 2015	33	1	30	6	0.15	[0.02; 1.19]	1.8%
Jo et al., 2013	20	4	18	10	0.36	[0.14; 0.95]	6.1%
Jo et al., 2011	15	4	17	7	0.65	[0.24; 1.78]	5.7%
Random-Effects Model (by subgroup)					**0.42**	**[0.22; 0.82]**	**13.6%**
LP PRP							
Pandey et al., 2016	52	2	50	10	0.19	[0.04; 0.83]	3.2%
Malavolta et al., 2018	22	0	22	1	0.33	[0.01; 7.75]	0.8%
Rossi et al., 2024	46	7	44	15	0.45	[0.20; 0.99]	7.7%
Yao et al., 2024 (LP)	46	0	23	0			0.0%
Random-Effects Model (by subgroup)					**0.37**	**[0.19; 0.73]**	**11.8%**
L PRF							
Zumstein et al., 2016	17	6	18	6	1.06	[0.42; 2.65]	6.5%
Random-Effects Model (by subgroup)					**0.71**	**[0.53; 0.95]**	**100.0%**

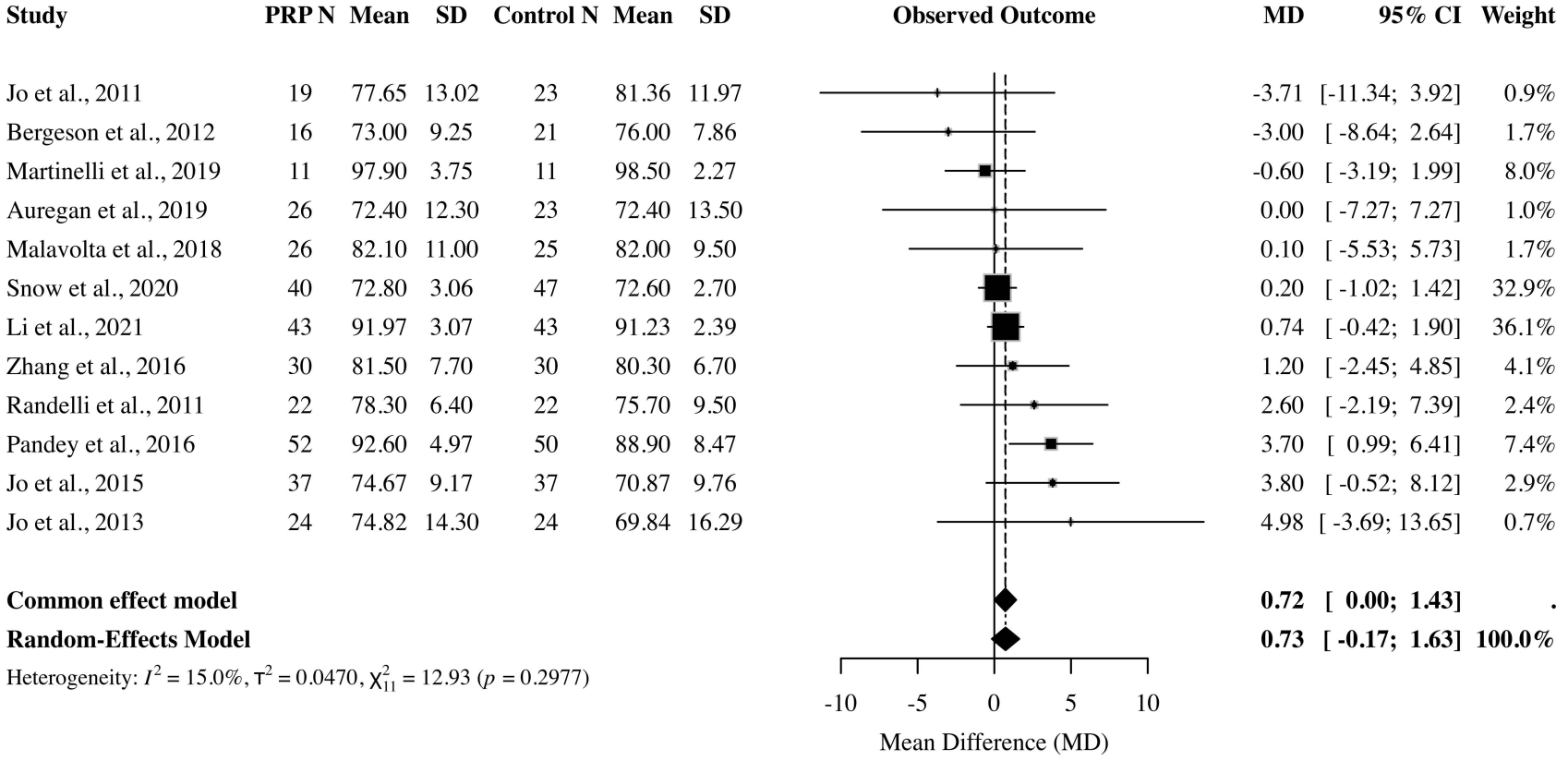
Test for subgroup differences: $\chi^2_4 = 7.76$, df = 4 ($p = 0.1007$)



Study	PRP N	Retears (PRP)	Control N	Retears (Control)	RR	95% CI	Weight
Medium Tears							
Jo et al., 2015	33	1	30	6	0.15	[0.02; 1.19]	1.6%
Yao et al., 2024 (LR)	40	0	24	1	0.20	[0.01; 4.76]	0.7%
Castricini et al., 2010	40	1	38	4	0.24	[0.03; 2.03]	1.5%
Zhang et al., 2016	30	1	30	3	0.33	[0.04; 3.03]	1.4%
Malavolta et al., 2018	22	0	22	1	0.33	[0.01; 7.75]	0.7%
Jo et al., 2013	20	4	18	10	0.36	[0.14; 0.95]	5.6%
Walsh et al., 2018	27	2	42	8	0.39	[0.09; 1.69]	2.9%
Rossi et al., 2024	46	7	44	15	0.45	[0.20; 0.99]	7.2%
Martinelli et al., 2019	11	2	10	3	0.61	[0.13; 2.92]	2.6%
Jo et al., 2011	15	4	17	7	0.65	[0.24; 1.78]	5.2%
Randelli et al., 2011	22	9	23	12	0.78	[0.41; 1.48]	9.2%
Zumstein et al., 2016	17	6	18	6	1.06	[0.42; 2.65]	6.0%
Auregan et al., 2019	26	10	23	7	1.26	[0.58; 2.77]	7.3%
Weber et al., 2013	28	12	24	7	1.47	[0.69; 3.13]	7.6%
Li et al., 2021	43	0	43	0			0.0%
Yao et al., 2024 (LP)	46	0	23	0			0.0%
Random-Effects Model (by subgroup)					**0.68**	**[0.48; 0.96]**	**59.8%**
Large Tears							
Pandey et al., 2016	52	2	50	10	0.19	[0.04; 0.83]	3.0%
Barber et al., 2011	20	6	20	12	0.50	[0.23; 1.07]	7.6%
Snow et al., 2020	39	6	38	8	0.73	[0.28; 1.91]	5.7%
Bergeson et al., 2012	16	9	21	8	1.48	[0.74; 2.96]	8.4%
Rodeo et al., 2012	36	12	31	6	1.72	[0.73; 4.05]	6.6%
Random-Effects Model (by subgroup)					**0.80**	**[0.41; 1.57]**	**31.2%**
Massive Tears							
Charousset et al., 2014	31	11	30	12	0.89	[0.46; 1.69]	9.0%
Random-Effects Model (by subgroup)					**0.74**	**[0.56; 0.98]**	**100.0%**

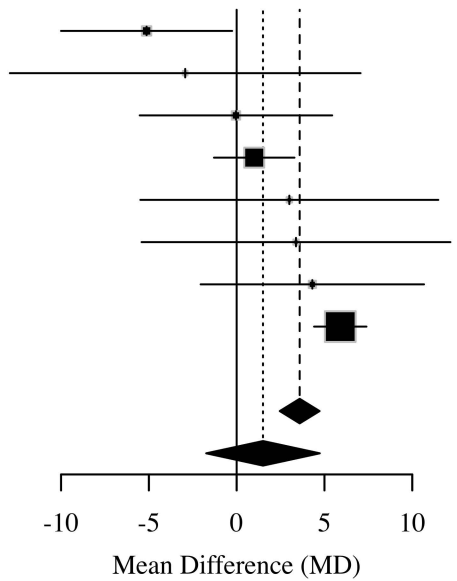
Test for subgroup differences: $\chi^2_2 = 0.62$, df = 2 ($p = 0.7335$)




Study
PRP N Mean SD
Control N Mean SD
Observed Outcome
MD 95% CI Weight
Jo et al., 2011 19 77.65 13.02 23 81.36 11.97 -3.71 [-11.34; 3.92] 0.9%
Bergeson et al., 2012 16 73.00 9.25 21 76.00 7.86 -3.00 [-8.64; 2.64] 1.7%
Martinelli et al., 2019 11 97.90 3.75 11 98.50 2.27 -0.60 [-3.19; 1.99] 8.0%
Auregan et al., 2019 26 72.40 12.30 23 72.40 13.50 0.00 [-7.27; 7.27] 1.0%
Malavolta et al., 2018 26 82.10 11.00 25 82.00 9.50 0.10 [-5.53; 5.73] 1.7%
Snow et al., 2020 40 72.80 3.06 47 72.60 2.70 0.20 [-1.02; 1.42] 32.9%
Li et al., 2021 43 91.97 3.07 43 91.23 2.39 0.74 [-0.42; 1.90] 36.1%
Zhang et al., 2016 30 81.50 7.70 30 80.30 6.70 1.20 [-2.45; 4.85] 4.1%
Randelli et al., 2011 22 78.30 6.40 22 75.70 9.50 2.60 [-2.19; 7.39] 2.4%
Pandey et al., 2016 52 92.60 4.97 50 88.90 8.47 3.70 [0.99; 6.41] 7.4%
Jo et al., 2015 37 74.67 9.17 37 70.87 9.76 3.80 [-0.52; 8.12] 2.9%
Jo et al., 2013 24 74.82 14.30 24 69.84 16.29 4.98 [-3.69; 13.65] 0.7%
Common effect model 0.72 [0.00; 1.43] .
Random-Effects Model 0.73 [-0.17; 1.63] 100.0%
Heterogeneity: I^2 = 15.0%, τ^2 = 0.0470, χ^2_{11} = 12.93 (p = 0.2977)
-10
-5
0
5
10
Mean Difference (MD)

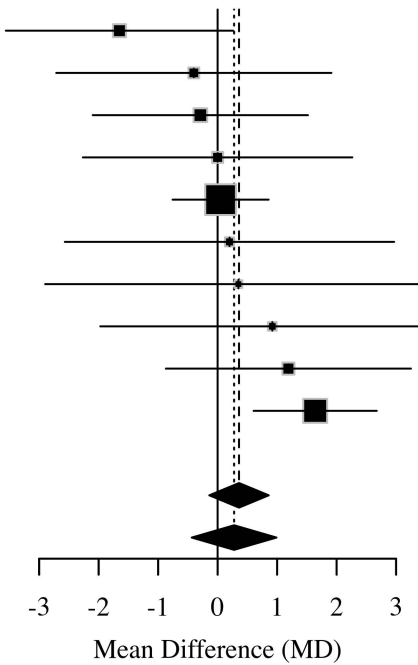
Study	PRP N	Mean	SD	Control N	Mean	SD	MD	95% CI	Weight
Rodeo et al., 2012	19	91.30	9.53	22	96.43	5.55	-5.13	[-10.00; -0.26]	13.9%
Jo et al., 2011	19	86.26	19.95	23	89.19	10.73	-2.93	[-12.91; 7.05]	6.3%
Weber et al., 2013	29	82.48	8.77	30	82.52	12.45	-0.04	[-5.52; 5.44]	12.7%
Pandey et al., 2016	52	87.40	5.46	50	86.40	6.30	1.00	[-1.29; 3.29]	19.6%
Bergeson et al., 2012	16	87.00	10.00	21	84.00	16.19	3.00	[-5.48; 11.48]	7.9%
Jo et al., 2013	24	88.94	13.61	24	85.56	17.26	3.38	[-5.41; 12.17]	7.5%
Jo et al., 2015	37	87.96	13.10	37	83.65	14.76	4.31	[-2.05; 10.67]	11.0%
Snow et al., 2020	40	80.10	3.39	47	74.20	3.70	5.90	[4.41; 7.39]	21.0%
Common effect model							**3.59**	**[2.45; 4.72]**	**.**
Random-Effects Model							**1.50**	**[-1.73; 4.73]**	**100.0%**

Heterogeneity: $I^2 = 76.5\%$, $\tau^2 = 10.3499$, $\chi^2_7 = 29.82$ ($p = 0.0001$)



Study	PRP N	Mean	SD	Control N	Mean	SD	MD	95% CI	Weight
Weber et al., 2013	29	27.94	4.98	30	29.59	1.68	-1.65	[-3.56; 0.26]	9.7%
Malavolta et al., 2018	26	32.10	4.60	25	32.50	3.80	-0.40	[-2.71; 1.91]	7.4%
Martinelli et al., 2019	11	32.81	2.04	11	33.10	2.28	-0.29	[-2.10; 1.52]	10.5%
Bergeson et al., 2012	16	29.00	3.75	21	29.00	3.10	0.00	[-2.26; 2.26]	7.6%
Li et al., 2021	43	32.13	1.79	43	32.08	2.02	0.05	[-0.76; 0.86]	22.2%
Randelli et al., 2011	22	31.20	5.20	22	31.00	4.10	0.20	[-2.57; 2.97]	5.6%
Jo et al., 2011	19	30.12	6.04	23	29.77	4.36	0.35	[-2.90; 3.60]	4.2%
Jo et al., 2013	24	30.13	3.97	24	29.21	6.04	0.92	[-1.97; 3.81]	5.2%
Jo et al., 2015	37	30.73	4.15	37	29.54	4.86	1.19	[-0.87; 3.25]	8.8%
Pandey et al., 2016	52	34.73	0.69	50	33.09	3.67	1.64	[0.61; 2.67]	18.8%
Common effect model							**0.36**	**[-0.14; 0.86]**	**.**
Random-Effects Model							**0.28**	**[-0.43; 0.99]**	**100.0%**

Heterogeneity: $I^2 = 28.0\%$, $\tau^2 = 0.4411$, $\chi^2_9 = 12.50$ ($p = 0.1868$)



Study	PRP N	Mean	SD	Control N	Mean	SD	MD	95% CI	Weight
Jo et al., 2015	37	1.17	1.44	37	1.57	1.82	-0.40	[-1.15; 0.35]	1.0%
Zhang et al., 2016	30	3.10	0.10	30	3.20	0.20	-0.10	[-0.18; -0.02]	85.7%
Li et al., 2021	43	0.30	0.49	43	0.32	0.50	-0.02	[-0.23; 0.19]	12.5%
Malavolta et al., 2018	26	1.50	2.10	25	1.40	1.80	0.10	[-0.97; 1.17]	0.5%
Martinelli et al., 2019	11	1.36	1.85	11	0.70	1.25	0.66	[-0.66; 1.98]	0.3%
Common effect model							**-0.09**	**[-0.16; -0.02]**	**.**
Random-Effects Model							**-0.09**	**[-0.17; -0.01]**	**100.0%**

Heterogeneity: $I^2 = 0.0\%$, $\tau^2 = 0$, $\chi^2_4 = 2.51$ ($p = 0.6425$)