

World Journal of *Meta-Analysis*

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The primary aim of *World Journal of Meta-Analysis* (*WJMA*, *World J Meta-Anal*) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality meta-analysis and systematic review articles and communicate their research findings online.

WJMA mainly publishes articles reporting research results and findings obtained through meta-analysis and systematic review in a wide range of areas, including medicine, pharmacy, preventive medicine, stomatology, nursing, medical imaging, and laboratory medicine.

INDEXING/ABSTRACTING

The *WJMA* is now abstracted and indexed in Reference Citation Analysis, China National Knowledge Infrastructure, China Science and Technology Journal Database, and Superstar Journals Database.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: *Hua-Ge Yu*; Production Department Director: *Xiang Li*; Editorial Office Director: *Jin-Lai Wang*.

NAME OF JOURNAL

World Journal of Meta-Analysis

ISSN

ISSN 2308-3840 (online)

LAUNCH DATE

May 26, 2013

FREQUENCY

Bimonthly

EDITORS-IN-CHIEF

Saurabh Chandan, Jing Sun

EDITORIAL BOARD MEMBERS

<https://www.wjgnet.com/2308-3840/editorialboard.htm>

PUBLICATION DATE

June 28, 2022

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INSTRUCTIONS TO AUTHORS

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PUBLICATION ETHICS

<https://www.wjgnet.com/bpg/GerInfo/288>

PUBLICATION MISCONDUCT

<https://www.wjgnet.com/bpg/gerinfo/208>

ARTICLE PROCESSING CHARGE

<https://www.wjgnet.com/bpg/gerinfo/242>

STEPS FOR SUBMITTING MANUSCRIPTS

<https://www.wjgnet.com/bpg/GerInfo/239>

ONLINE SUBMISSION

<https://www.f6publishing.com>

Evidence analysis on the utilization of platelet-rich plasma as an adjuvant in the repair of rotator cuff tears

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Specialty type: Orthopedics

Provenance and peer review:

Invited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): 0
Grade C (Good): C, C, C
Grade D (Fair): D, D
Grade E (Poor): 0

P-Reviewer: Belluzzi E, Italy;
Haque N, Bangladesh; Yang YZ, China; Zhang W, China; Zhu L, China

Received: December 18, 2021

Peer-review started: December 18, 2021

First decision: March 13, 2022

Revised: March 23, 2022

Accepted: June 21, 2022

Article in press: June 21, 2022

Published online: June 28, 2022



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Abstract

BACKGROUND

Platelet-rich plasma has been gaining popularity as an agent for biological augmentation either as the sole treatment modality or as an adjunct to surgical repair. There is substantial discrepancy in the results of the published meta-analyses; and the true efficacy and role of using autologous platelet-rich plasma (PRP) at the time of rotator cuff repair is still ambiguous.

AIM

To performed this systematic overview on the overlapping meta-analyses that analyzed autologous PRP as an adjuvant in the repair of rotator cuff tears and identify the studies which provide the current best evidence on this subject and generate recommendations for the same.

METHODS

We conducted independent and duplicate electronic database searches in PubMed, Web of Science, Scopus, Embase, Cochrane Database of Systematic Reviews, Reference Citation Analysis and the Database of Abstracts of Reviews of Effects on September 8, 2021 to identify meta-analyses that analyzed the efficacy of PRP as an adjuvant in the repair of rotator cuff tears. Methodological quality assessment was made using Oxford Levels of Evidence, AMSTAR scoring and AMSTAR 2 grades. We then utilized the Jadad decision algorithm to identify the study with the highest quality to represent the current best evidence to generate the recommendation.

RESULTS

Twenty meta-analyses fulfilling the eligibility criteria were included. The AMSTAR scores of the included studies varied from 6-10 (mean: 7.9). All the included studies had critically low reliability in their summary of results due to their methodological flaws according to AMSTAR 2 grades. Significant heterogeneity was observed in the reporting of VAS, function outcome scores (long-term UCLA score, ASES score, SST score), operative time and long-term re-tear rates. Recent meta-analyses are more supportive of the role of intra-operative administration of PRPs at the bone-tendon interface in improving the overall healing and re-tear rates, functional outcome and pain. The initial size of the tear and type of repair performed do not seem to affect the benefit of PRPs. Among the different preparations used, leucocyte poor (LP)-PRP possibly offers the greatest benefit as a biological augment in these situations.

CONCLUSION

Based on this systematic overview, we give a level II recommendation that intra-operative use of PRPs at the bone-tendon interface can augment the healing rate, reduce re-tears, enhance functional outcome and mitigate pain in patients undergoing arthroscopic rotator cuff repair. LP-PRP possibly offers the greatest benefit in terms of healing rates, as compared with other platelet preparations.

Key Words: Platelet-rich plasma; Rotator cuff tears; Meta-analyses; Functional outcome; Re-tear; Recommendation

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Core Tip: Platelet-rich plasma has been gaining popularity as an agent for biological augmentation either as the sole treatment modality or as an adjunct to surgical repair. There is growing evidence on the positive effects of platelet-derived autologous growth factors on collagen production, cell proliferation, tissue revascularization and tendon regeneration thereby making them useful as an augment to arthroscopic rotator cuff repair. Based on our analysis, we found that the intra-operative use of PRPs at the bone-tendon interface can augment the healing rate, reduce re-tears, enhance functional outcome and mitigate pain in patients undergoing arthroscopic rotator cuff repair.

Citation: Muthu S, Jeyaraman N, Patel K, Chellamuthu G, Viswanathan VK, Jeyaraman M, Khanna M. Evidence analysis on the utilization of platelet-rich plasma as an adjuvant in the repair of rotator cuff tears. *World J Meta-Anal* 2022; 10(3): 143-161

URL: <https://www.wjgnet.com/2308-3840/full/v10/i3/143.htm>

DOI: <https://dx.doi.org/10.13105/wjma.v10.i3.143>

INTRODUCTION

Despite substantial improvements and huge strides made in the surgical procedures and the fixation constructs employed in the repair of rotator cuff tears, high failure rates persist to remain a major cause for concern[1]. The reported failure rates of rotator cuff repairs vary between 8 and 94% [1-4]; and multitudinous factors including age, systemic comorbidities, smoking status, size of tear, degree of fatty infiltration and surgical approaches or techniques have been purported to determine the outcome in these patients[5].

With the understanding that there is still room for significant improvement, the need for employing additional modalities for ameliorating healing in this setting has been growingly acknowledged[6]. It has been well-demonstrated that degenerated rotator cuff tissue has substantially compromised microcirculation, as compared with normal, healthy tissue[7]. Moreover, the fibro-vascular scar at the region of the bone-tendon interface following repair of the rotator cuff tear is of poorer quality in comparison with the innate tissue[8]. Since these aforementioned biological factors have been postulated to be the potential underlying cause for impaired tendon healing capacity after surgical repair, a significant degree of promise has been recently placed on biological augmentation strategies for enhancing tissue healing after rotator cuff repair surgeries[1,9].

Platelet-rich plasma (PRP) is a platelet concentrate which is prepared by centrifugation of autologous whole blood; and contains various growth factors including platelet-derived growth factor, insulin-like growth factor, transforming growth factor- β , epidermal growth factor and vascular endothelial growth factor. Based on the preparations and constitution (leukocyte content and fibrin architecture), PRP have been classified as pure PRP, leucocyte and PRP (L-PRP), leucocyte and platelet-rich fibrin (L-PRF) and pure platelet-rich fibrin (P-PRF)[1-6]. PRP and platelet-rich fibrin matrix have been gaining popularity as agents for biological augmentation in diverse sub-specialties of orthopedic surgery, either as the sole treatment modality or as an adjunct to surgical repair[8,9]. There is growing evidence from animal-based models on the positive effects of platelet-derived autologous growth factors on collagen production, cell proliferation, tissue revascularization and tendon regeneration in the setting of operative arthroscopic rotator cuff repair (ARCR)[10,11]. Nevertheless, there is substantial discrepancy in the results of the published meta-analyses; and the true efficacy and role of using PRP at the time of rotator cuff repair is still ambiguous[12-16].

The overall purpose of the current study was to perform a detailed systematic review of the existing meta-analyses evaluating the role of PRP in patients undergoing rotator cuff repair; and to specifically provide answers to the following research questions, namely: (1) To evaluate the effect of this strategy on overall clinical outcome scores; (2) To evaluate the reduction in re-tear or failure rates; (3) To analyze the evolution and variations in the techniques of procurement and application of PRP across different studies; (4) To critically analyze and interpret the best currently available evidence and provide recommendations; and (5) To discern the major gaps in the existing literature and identify the scope for future research on this subject.

MATERIALS AND METHODS

We present herewith a systematic overview of meta-analyses, performed by duly cohering the guidelines of the Back Review Group of Cochrane Collaboration[17]; and aim to report the same based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[18].

Search strategy

Two reviewers performed an independent literature search for systematic reviews with meta-analysis evaluating PRP therapy along with surgical repair for rotator cuff tear. The comprehensive search was performed on the electronic databases including PubMed, Web of Science, Scopus, Embase, Cochrane Database of Systematic Reviews, Reference Citation Analysis and the Database of Abstracts of Reviews of Effects on September 8, 2021. Our search was neither restricted to any specific language nor confined to any particular period. The electronic search strategy was designed in accordance with the Peer Review of Electronic Search Strategy (PRESS) guidelines[19]. The keywords used for the search included: "Platelet-rich Plasma", "PRP", "rotator cuff repair", "rotator cuff tear", "clinical outcome", "re-tear rate", "failure rate", "Systematic Review", "Meta-analysis" together with Boolean operators such as "AND", "OR" and "NOT". A manual search of the key journals was made; and reference list of the selected articles was searched to identify studies not identified in the primary search. Additionally, a search was also made in the International prospective register of systematic reviews for any ongoing review which is nearing completion. All the studies meeting the inclusion criteria were included and analyzed. Any discrepancy between the two reviewers was resolved through discussion until a consensus was achieved. The PRISMA flow chart for the study selection into systematic overview has been shown in [Figure 1](#).

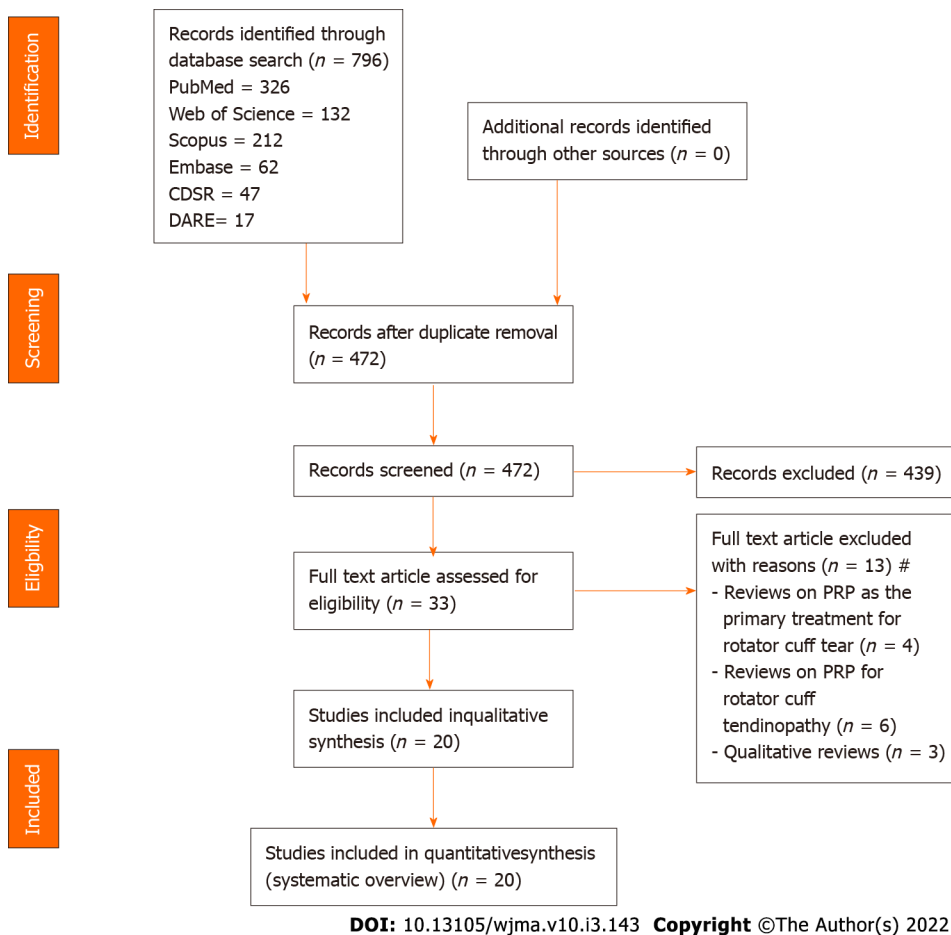


Figure 1 PRISMA flow diagram of the included studies.

Inclusion criteria

Review articles were included in our study if they satisfied the following criteria: Systematic review with meta-analysis comparing surgical repair with and without PRP for rotator cuff tears. Studies which analyzed at least one of the outcome measures like Visual analog scale (VAS) score, Disabilities of the Arm, Shoulder and Hand (DASH) score, Constant score, University of California Los Angeles (UCLA) score, American Shoulder and Elbow Surgeons (ASES) score, Simple Shoulder Test (SST) score, operating time, patient satisfaction, tendon healing and re-tear rates.

Exclusion criteria

Narrative reviews, systematic reviews without data pooling/meta-analysis, systematic reviews with mixed intervention groups, correspondence articles, pre-clinical studies, studies on animal models and cadaveric studies were excluded.

Data extraction

Data was extracted from meta-analyses by two reviewers independently. Notably, data extracted from the studies included: First author details, date of last literature search performed, year and journal of publication, number, and nature of studies included, language restrictions, criteria for inclusion and exclusion for studies, databases used for literature search, software employed for analysis, subgroup/sensitivity analysis, analysis of publication bias, conflict of interest, Grading of Recommendations Assessment, Development, and Evaluation (GRADE) summary, and I^2 statistic value of variables in each meta-analysis. Disagreements were settled by consensus.

Assessment of quality of study methodology

The methodological quality of included reviews was evaluated using Oxford Levels of Evidence[20]. Additionally, the Assessment of Multiple Systematic Reviews (AMSTAR)[21] and its updated grading tool AMSTAR 2[22] were also used to assess their methodological robustness with good validity and reliability[23]. Two reviewers independently assessed quality of methodology of the included studies. Disagreements were settled by consensus.

Heterogeneity assessment

I^2 test was used for the assessment of heterogeneity[24]. When $I^2 > 50\%$ and $P < 0.1$, heterogeneity is deemed to exist among included trials; and the reviewers evaluated whether the studies utilized sensitivity or subgroup analyses to assess the reasons for heterogeneity and strengthen the robustness of pooled data.

Application of Jadad decision algorithm

Variability in the findings among included meta-analyses was interpreted with the help of Jadad decision algorithm. As per Jadad *et al*[25], possible reasons for discordance in the results among studies include differences in study question, inclusion and exclusion criteria, quality assessment, data pooling/extraction and statistical analysis. Currently, this is the most commonly used algorithm for generating recommendations among meta-analyses with discordant results[26-29]. Two reviewers used this algorithm independently to arrive at a single meta-analysis representing the current best evidence in order to generate recommendations.

RESULTS

Search results

A comprehensive search of the electronic database generated 838 articles which were subjected to an initial screening for removing duplicate articles. This yielded 514 articles. Further screening of title and abstract resulted in the exclusion of 481 articles. Therefore, 33 articles qualified for reviewing the full-text. Upon full-text review by both reviewers, 13 were excluded. Finally, 20 meta-analyses were included in this systematic review[30-46,1,47,48]. These overlapping meta-analyses were published in different journals between 2012 and 2021; and the number of studies included in them ranged between 5 and 19 (Table 1). The publication years of the included studies in these meta-analyses ranged between 2008 and 2020 as shown in Supplementary Table 1.

Search methodology of the meta-analyses

Although the included meta-analyses made a comprehensive literature search, the search databases employed were not similar. Sixteen, 1 and 7 studies searched PubMed, Embase and Medline databases, respectively. While 2 of them searched the Cochrane library, one searched Web of Science. 18 searched Scopus, 16 Google Scholar, 3 Cumulative Index to Nursing and Allied Health Literature (CINAHL) database, 2 China National Knowledge Infrastructure (CNKI) database, 1 Wan fang and 2 meta-analyses searched VIP database. Of the 20 studies, 4 included studies only in English[1,42,43,46] while 7 others mentioned no linguistic restriction in their search criteria[30,33,38,40,41,44,45]. Further details regarding the search methodology employed in the included meta-analyses has been presented in Table 2.

Methodological quality

Using Oxford Levels of Evidence, the quality of included studies was determined based on the nature of primary studies considered in the analysis. Of the 20 studies analyzed, 6 were of level-II evidence, one level-III and the rest of them were of level III evidence (Table 3). Among the 20 studies, 12 used RevMan5.3, 4 used Stata software, 1 used open meta, 2 used R-foundation for data analyses; while in one study, the software employed was not mentioned (Table 3). Additionally, three studies utilized the GRADE system, 12 studies performed sensitivity analysis and 16 conducted sub-group analysis to explore the heterogeneity in their results. Eleven studies assessed for possible publication bias.

As shown in Table 4, AMSTAR scores of included studies ranged between 6 and 10 (mean 7.8). Based on AMSTAR-2 grading, none of the studies were without any critical methodological flaw in the conduction of meta-analysis. Among all included studies, the meta-analysis by Zhang *et al*[30] was found to be of the highest quality with an AMSTAR score of 10/11 (Table 4). However, this study also suffered from critical methodological flaws of including status of publication (*i.e.* grey literature) as a criterion for inclusion and did not provide the list of (included and excluded) studies.

Assessment of heterogeneity

All the studies included used I^2 statistic for heterogeneity assessment. Mild heterogeneity was noted in short-term UCLA score, tendon healing rates and patient satisfaction. Heterogeneity in the reporting of DASH score, Constant score and short-term re-tear rate was moderate; while heterogeneity of VAS, long-term UCLA score, ASES score, SST score, operative time and long-term re-tear rates was significant (Table 5). It is of utmost importance to probe into source of discordance among included studies, as recommendations generated are put into clinical practice and for developing public health-care policies [49]. The heterogeneity of results among the meta-analyses was primarily due to variation in the nature of primary studies included (other than RCTs).

Table 1 Characteristics of the included studies

Sl. No	Ref.	Publication date	Publication journal	Literature search date	No. of studies included
1	Chahal et al[32], 2012	June 14, 2012	<i>Arthroscopy: The Journal of Arthroscopic and Related Surgery</i>	December 30, 2011	5
2	Moraes et al[31], 2013	December 23, 2013	<i>Cochrane Database of Systematic Reviews</i>	March 25, 2013	19
3	Zhang et al[30], 2013	July 12, 2013	<i>PLoS One</i>	April 20, 2013	7
4	Li et al[33], 2014	June 7, 2014	<i>Arthroscopy: The Journal of Arthroscopic and Related Surgery</i>	May 1, 2013	7
5	Zhao et al[29], 2014	September 30, 2014	<i>Arthroscopy: The Journal of Arthroscopic and Related Surgery</i>	September, 2013	8
6	Warth et al[35], 2014	November 13, 2014	<i>Arthroscopy: The Journal of Arthroscopic and Related Surgery</i>	September, 2013	11
7	Vavken et al[36], 2015	March 12, 2015	<i>The American Journal of Sports Medicine</i>	August 1, 2014	13
8	Cai et al[38], 2015	October 8, 2015	<i>Journal of Shoulder and Elbow Surgery</i>	January, 2015	5
9	Xiao et al[37], 2016	October 30, 2016	<i>International Journal of Clinical and Experimental Medicine</i>	February 1, 2016	15
10	Hurley et al[40], 2018	February 21, 2018	<i>The American Journal of Sports Medicine</i>	March 24, 2017	18
11	Han et al[39], 2019	June 20, 2019	<i>Journal of Orthopaedic Surgery and Research</i>	September, 2016	13
12	Wang et al[41], 2019	July 29, 2019	<i>PLoS One</i>	September 15, 2018	8
13	Chen et al[42], 2019	November 19, 2019	<i>The American Journal of Sports Medicine</i>	December, 2017	18
14	Cavendish et al[43], 2020	May 1, 2020	<i>Journal of Shoulder and Elbow Surgery</i>	May 23, 2018	16
15	Hurley et al[44], 2020	July 30, 2020	<i>The American Journal of Sports Medicine</i>	March, 2020	13
16	Yang et al[45], 2020	October 14, 2020	<i>Nature research</i>	February 15, 2020	7
17	Zhao et al[46], 2020	November 18, 2020	<i>Journal of Shoulder and Elbow Surgery</i>	March, 2020	10
18	Ryan et al[1], 2021	March 17, 2021	<i>Arthroscopy: The Journal of Arthroscopic and Related Surgery</i>	June, 2020	17
19	Xu et al[48], 2021	July 13, 2021	<i>The Orthopaedic Journal of Sports Medicine</i>	June 20, 2020	14
20	Li et al[47], 2021	May 27, 2021	<i>Arthroscopy: The Journal of Arthroscopic and Related Surgery</i>	October 29, 2020	

Results of Jadad decision algorithm

The pooled results from each included meta-analysis are presented in Figure 2. To identify the study which provides the best possible evidence to generate treatment recommendations, the Jadad decision algorithm was adopted. Two authors independently applied the decision algorithm to determine the meta-analysis with the highest quality to develop recommendation on the use of PRP in ARCR. Considering that all the 20 studies aimed to answer similar clinical questions despite analyzing a varied spectrum of primary studies, the study with the highest quality was selected on the basis of its methodological quality, restrictions involved (such as language or publication status), databases involved and analysis protocols adopted (Figure 3).

Based on this algorithm, the meta-analysis by Zhang et al[30] was determined to be the highest-quality study. This study observed no major benefits on overall clinical outcomes and re-tear rate following PRP administration in full-thickness rotator cuff tears; while a reduction in the rate of re-tears was demonstrated for small- and medium-sized tears. However, the selected study is also not free of critical methodological flaws based on AMSTAR 2 criteria. Hence, we analyzed the rationale for the development of the succedent systematic reviews as in Table 6 and tried to understand the evolution, variation in the techniques of procurement and application of PRP across different studies with due consideration to the high-quality evidence developed in the recent years and arrived at the following results.

Significant heterogeneity was observed in the reporting of VAS, function outcome scores (long-term UCLA score, ASES score, SST score), operative time and long-term re-tear rates. Recent meta-analyses are more supportive of the role of intra-operative administration of PRPs at the bone-tendon interface in

Table 2 Search methodology used by each study

Sl. No	Search parameters	Chahal (2012)	Moraes (2013)	Zhang (2013)	Li (2014)	Zhao (2015)	Warth (2015)	Vavken (2015)	Cai (2015)	Xiao (2016)	Hurley (2018)	Han (2019)	Wang (2019)	Chen (2019)	Cavendish (2020)	Hurley (2020)	Yang (2020)	Zhao (2021)	Ryan (2021)	Xu (2021)	Li (2021)
1	Publication language restriction	X	X	NA	X	X	X	X	NA	X	NA	X	NA	√	√	NA	NA	√	√	X	NA
2	Publication status restriction	X	NA	NA	NA	X	NA	NA	NA	X	X	NA	NA	X	NA	X	NA	NA	NA	X	NA
3	PubMed	√	X	√	√	√	√	√	√	√	X	√	√	√	√	X	√	√	√	X	√
4	Medline	√	√	X	X	X	X	X	X	X	√	X	X	√	X	√	X	X	√	√	X
5	Embase	X	X	X	√	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6	Cochrane library	X	X	X	√	X	X	X	X	X	X	X	X	X	X	X	X	X	X	√	X
7	Web of Science	X	√	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	Scopus	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√	√	√	X	√	√
9	Google Scholar	√	√	√	X	√	X	√	X	√	√	√	√	√	X	√	√	√	√	√	√
10	CINAHL	X	X	X	X	X	X	X	√	√	X	X	X	X	X	X	X	X	X	X	√
11	AMED	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
12	CNKI	X	X	X	X	X	X	X	X	√	X	X	X	X	X	X	√	X	X	X	X
13	Wan Fang	X	X	X	X	X	X	√	X	X	X	X	X	X	X	X	X	X	X	X	X
14	CBM literature	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
15	VIP	X	X	X	X	X	X	X	X	X	√	X	X	X	X	√	X	X	X	X	X

AMED: Allied and Complementary Medicine; CBM: Chinese BioMedical database; CINAHL: Cumulative Index to Nursing and Allied Health Literature; CNKI: Chinese National Knowledge Infrastructure; NA: Not available; VIP: Chinese Scientific Journals Database.

improving the overall healing and re-tear rates, functional outcome and pain. The initial size of the tear and type of repair performed do not seem to affect the benefit of PRPs. Among the different preparations used, leucocyte poor (LP)-PRP possibly offers the greatest benefit as a biological augment in these situations.

Major conclusions from the individual studies

Different studies employed specific criteria to include studies with an aim to provide more useful and relevant information as compared to the previously-published literature. Chen *et al*[42] (2019), Hurley *et*

Table 3 Methodological information of each study

Sl. No	Search parameters	Chahal (2012)	Moraes (2013)	Zhang (2013)	Li (2014)	Zhao (2015)	Warth (2015)	Vavken (2015)	Cai (2015)	Xiao (2016)	Hurley (2018)	Han (2019)	Wang (2019)	Chen (2019)	Cavendish (2020)	Hurley (2020)	Yang (2020)	Zhao (2021)	Ryan (2021)	Xu (2021)	Li (2021)	
1	Primary study design	RCT, CCT,RCS	RCT	RCT	RCT	RCT	RCT CCT	RCT	RCT	RCTCCT	RCT	RCT	RCT	RCT	RCT	RCT	RCT	RCT	RCT	RCT	RCT	RCT
2	Level of Evidence	III	I	I	II	I	II	I	I	II	I	I	I	I	II	I	I	II	I	I	I	II
3	Software Used	RevMan 5.3	RevMan 5.3	RevMan 5.3	NA	RevMan 5.3	Open Meta	STATA 10	RevMan 5.3	RevMan 5.3	RevMan 5.3	RevMan 5.3	RevMan 5.3	STATA 15.1	STATA 13	R Foundation (netmeta package Version 0.9-6 in R)	RevMan 5.3	RevMan 5.3	R Foundation for Statistical Computing, Vienna, Austria	STATA 15	RevMan 5.3	
4	GRADE Used	X	√	X	X	√	X	X	X	X	X	X	√	X	X	X	X	X	X	X	X	X
5	Sensitivity Analysis	√	√	X	√	√	√	√	X	√	X	√	√	√	X	X	X	√	X	X	X	√
6	Subgroup Analysis	√	√	√	X	√	√	√	√	X	√	√	√	√	√	X	√	√	√	√	√	X
7	Publication Bias	X	√	√	X	√	√	√	√	√	X	√	√	√	√	X	X	X	X	X	X	X

CCT: Controlled clinical trial; GRADE: Grading of Recommendations Assessment, Development and Evaluation system; NA: Not available; RCTs: Randomized controlled trials; RCS: Retrospective cohort study.

al[44] (2020), Zhao *et al*[46] (2021), Ryan *et al*[1] (2021) and Li *et al*[47] (2021) compared the effects of PRP preparations on the basis of their relative leukocyte concentrations[1,42,44,46,47].

The initial studies by Chahal *et al*[32] (2012), Moraes[31] (2013), Zhang *et al*[30] (2013), Li *et al*[33] (2014), Zhao *et al*[34] (2014) and Xiao *et al*[37] (2016) did not reveal any benefit following PRP application [31-34,37]. Warth *et al*[35] (2014), Hurley *et al*[44] (2018) and Xu *et al*[48] (2021) observed that PRP was more helpful in enhancing the healing rates of large-sized tears[44,48]. Vavken *et al*[36] (2015) and Cai *et al*[38] (2015) reported better outcome following PRP application in small- to medium-sized tears[36,38]. The recent studies published by Han *et al*[39] (2019), Wang *et al*[41] (2019), Chen *et al*[42] (2019), Yang *et al*[45] (2020) and Cavendish *et al*[43] (2020) concluded that intraoperative PRP application significantly enhanced the short- and long-term clinical outcome and mitigated the re-tear rates after RC repair[39,41-43,45]. The recently-published literature [Hurley *et al*[44] (2020), Zhao *et al*[46] (2021), Ryan *et al*[1] (2021), Li *et al*[47] (2021) and Xu *et al*[48] (2021)] also seemed to demonstrate better outcome (functional scores and re-tear rates) with LP-PRP, as compared with LR-PRP[1,33,44,46,48]. The individual data of the included studies are presented in Table 6.

Table 4 AMSTAR scores and AMSTAR 2 grading for included studies

Sl. No	AMSTAR domains	Chahal (2012)	Moraes (2013)	Zhang (2013)	Li (2014)	Zhao (2015)	Warth (2015)	Vavken (2015)	Cai (2015)	Xiao (2016)	Hurley (2018)	Han (2019)	Wang (2019)	Chen (2019)	Cavendish (2020)	Hurley (2020)	Yang (2020)	Zhao (2021)	Ryan (2021)	Xu (2021)	Li (2021)
1	Was a priori design provided?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	Were there duplicate study selection and data extraction?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
3	Was a comprehensive literature search performed?	1	1	0	1	0	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1
4	Was the status of publication (<i>i.e.</i> grey literature) used as an inclusion criterion?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Was a list of studies (included and excluded) provided?	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Were the characteristics of the included studies provided?	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
7	Was the scientific quality of the included studies assessed and documented?	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
8	Was the scientific quality of the included studies used appropriately in formulating conclusions?	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1
9	Were the methods used to combine the findings of studies appropriate?	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
10	Was the likelihood of publication bias assessed?	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0
11	Was the conflict of interest stated?	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1
	Total AMSTAR score	8	8	10	8	8	7	8	6	8	8	8	8	7	9	8	8	6	7	8	8
	Critical Methodological Flaw	3	3	1	3	2	2	3	5	2	3	2	3	4	1	3	3	4	4	3	2

Non-Critical Flaw	1	1	1	1	1	3	1	1	2	1	1	1	1	1	1	1	2	1	1	1
AMSTAR 2 Grade	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL

AMSTAR: Assessing the Methodological Quality of Systematic Reviews; CL: Critically low.

DISCUSSION

To date, numerous RCTs have analyzed the efficacy of adjuvant PRP therapy in patients undergoing surgical repair of RC tears[6,30,39]. Although theoretically, biological augmentation with PRP can potentially enhance healing and mitigate failure rates after arthroscopic rotator cuff repair, our understanding of the exact role of PRP therapy in this scenario is still ambiguous[9,33]. Limited sample sizes, heterogeneity in the treatment protocols, PRP preparations and techniques employed; and the paucity of long- term results have been the major limitations of the currently published studies on this subject[1,6].

To further strengthen the results, multiple meta-analyses have been conducted to consolidate the findings of more recent RCTs, so as to provide the higher level of evidence on the effectiveness of the intervention in operatively-treated RC tears[6]. However, the spectra of primary studies included in the recent analysis and the databases utilized for study inclusion are still discordant[1,37,48]. Hence, a systematic overview of these overlapping meta-analyses was planned in order to identify the highest quality study among the available studies; as well as to formulate and generate recommendations regarding the use of adjuvant PRP in such situations.

Platelets are a source of high concentrations of different growth factors (like platelet-derived growth factor, transforming growth factor-beta, fibroblast growth factor, vascular endothelial growth factor and epidermal growth factor) which can potentially stimulate cell proliferation. They form a temporary matrix which can fill the defects and thereby provide a scaffold for cell migration and tissue remodeling [34]. The earliest meta-analysis on this subject was published by Chahal *et al*[32] in 2013. Although they observed marginal benefits in small and moderate sized tears, there was no major improvement in the overall re-tear rates or shoulder-specific outcomes after ARCR in larger or at-risk tears. Following this, in a Cochrane review, Moraes *et al*[31] reviewed studies involving intra-operative application of PRP; and concluded marginal benefits of PRP administration, especially with respect to improvements in short-term VAS and short-term re-tears. There has been a recent surge in the number of meta-analyses published on this subject since 2020[1,34,47,48]. While a majority of the older meta-analyses failed to show any major benefit of PRP therapy in this cohort of patients, more recent studies seem to re-iterate the potential benefits of adjuvant PRP treatment as evident from Figure 2. Older age, number of tendons involved, large tear size, duration of pre-operative symptoms and degree of pre-operative fatty degeneration have been postulated as some of the major factors predictive of high post-operative re-tear rates[32]. Table 6 discusses in detail the observations of each of these meta-analyses and enlists the reasons put forth by authors on the need for performing an additional meta-analysis in the presence of multiple pre-existing studies in the literature.

Among all the initial meta-analyses, the study with an excellent quality of methodology and a larger sample size and minimal heterogeneity was published by Zhang *et al*[30] in 2013. This study also

Table 5 P statistic values of variables analyzed in each meta-analysis

Sl. No	Outcome variables	Chahal (2012)	Zhang (2013)	Moraes (2013)	Li (2014)	Zhao (2015)	Warth (2015)	Vavken (2015)	Cai (2015)	Xiao (2016)	Hurley (2018)	Han (2019)	Wang (2019)	Chen (2019)	Hurley (2020)	Yang (2020)	Cavendish (2020)	Zhao (2021)	Ryan (2021)	Xu (2021)	Li (2021)	
1	VAS Score – Short term			29.9%+						0%-	38%-		0%-			60.5%+		0%+	0%+	0%+		
2	VAS Score – Long term			67%-			0%-			0%-	0%-	0%+	0%-	87.5%-	0%+	0%-		0%+		4%+	63%+	
3	DASH Score – Short term									0%-			32%-			30%-						
4	DASH Score – Long term			0%-						NR-			0%-			0%-					32%-	
5	Constant Score – Short term									30%+			0%+			0%+					23%+	
6	Constant Score – Long term	NR-	17%-	50%+	86%-	0%-	26%-		0%-	0%-	0%-	0%+	0%-	30.7%+	0%+	0%-		19%+	36%+	47%+	0%+	
7	UCLA Score – Short term									0%+			8.9%+			0%+					0%+	
8	UCLA Score – Long term	NR-	0%-	35.18%-	75%-	0%-	0%-		60%-	47%-	0%-	47%+	12%+		0%+	0%-		49%+	64.18%-	63%+	46%+	
9	ASES Score		0%-	0%-	46%-		58%-		0%-	54%-	0%-	26%-						0%-	41%-	52%-	0%+	
10	SST Score	NR-	47%-	0%+	90%-		0%-		0%-	47%-		0%+							0%+		0%-	
11	Operative time									85%-												
12	Patient Satisfaction			0%-						0%-												
13	Tendon healing rate								0%+	0%-					0%+			10%-				
14	Retear rate – Short term		0%-	25%+				15.2%-		30%-			0%+					0%+			0%-	
15	Retear rate – Long term	0%+	11%-	14%-	22%-	43%-		0%-	0%-	71%-		0%+	0%-	0%+	0%+	0%+	0%+	0%+	0%+	NA+	4.7%+	22%+

ASES: American Shoulder and Elbow Surgeons; DASH: Disabilities of the Arm, Shoulder and Hand; SST: Simple Shoulder Test; UCLA: University of California Los Angeles; VAS: Visual analog scale.

concluded that adjuvant PRPs could reduce the re-tear rates in small and medium-sized rotator cuff tears but not in massive or full-thickness tears. The meta-analyses by Li *et al*[33] (2014) and Zhao *et al*[34] (2014) incorporated a few more later-published RCTs. Both these studies did not reveal any major benefits of PRPs in terms of both clinical outcome scores and re-tear rates.

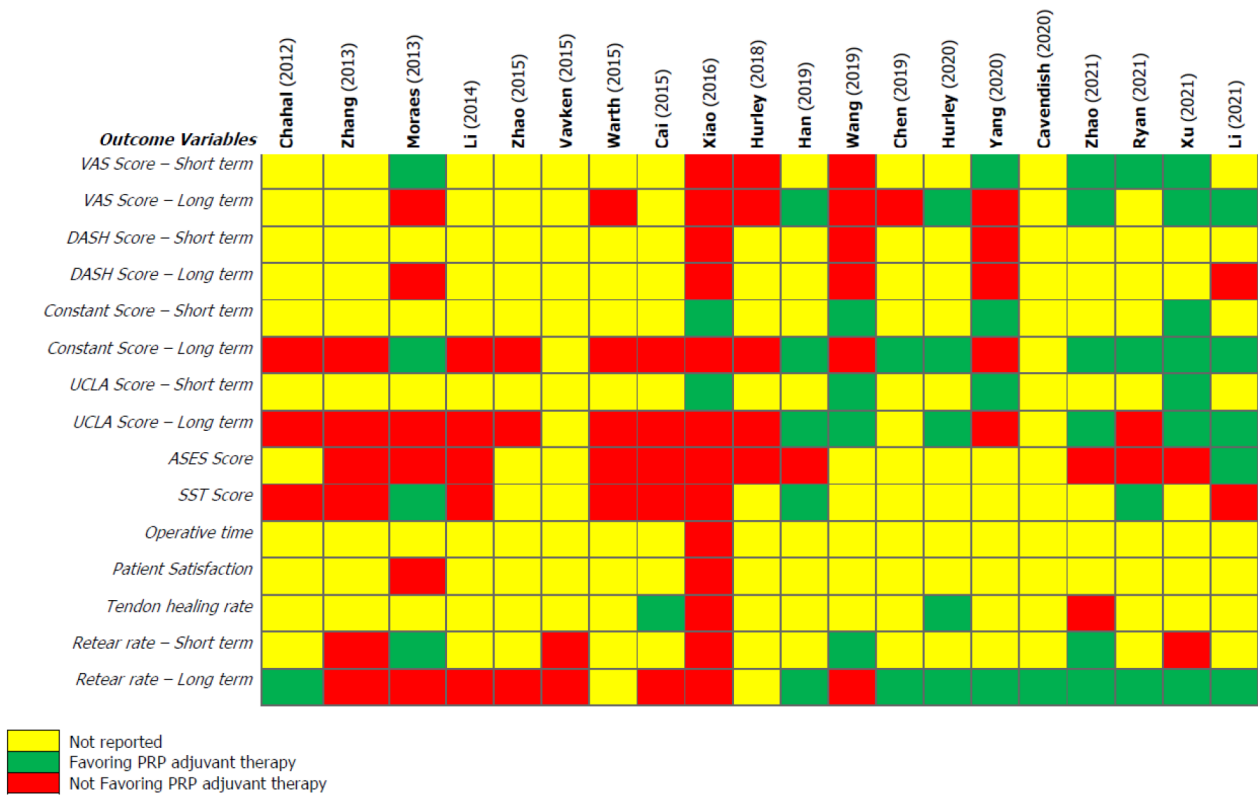
Warth *et al*[35] (2014) conducted a meta-regression analysis to evaluate the effect of 6 different co-variables (level of studies included, tear size, single- *vs* double-row repairs, types of PRP preparation, manual *vs* commercially available PRP preparations; and method of application of PRP) on overall clinical and structural outcome. They concluded that Constant scores were significantly improved when the PRPs were applied over the tendon-bone interface; and re-tears were significantly reduced in tears larger than 3 cm which were repaired using the double-row technique. In contrast, both the meta-analysis [Vavken *et al*[36]; Cai *et al*[38] (which included only RCTs)] published following this study revealed no benefit in large, full-thickness tears. In both these studies, PRPs enhanced healing rates only in small- to moderate-sized tears. Additionally, Vavken *et al*[36] concluded that despite its biological effectiveness; at the present costs, the use of PRPs is not a cost-effective strategy in arthroscopic repair of small- to moderate-sized RC tears. Another meta-analysis by Xiao *et al*[37] (2016) tried to enhance the power of the analysis by including both level I and II studies. Nevertheless, they too failed to reveal any major benefit in terms of both clinical outcome and re-tear rates. By being less selective in including studies for analysis, the quality of the meta-analysis also significantly deteriorated as compared to previous studies.

Between 2016 and 2018, many new RCTs were performed; and 4 new meta-analyses were published in 2018 and 2019 which included these recent studies as well. Hurley *et al*[40] (2018; involving 18 studies) compared PRP and platelet-rich fibrin (PRF) in ARCR. They concluded that PRPs improved pain score (short-term and long-term), Constant score and re-tear rates in RC tears of all sizes. Another similar study by Han *et al*[39] (involving 13 RCTs) also reported reduced re-tear rate and meliorated clinical outcome with PRP therapy in ARCR. Wang *et al*[41] (2019; included only 8 RCTs) observed good outcomes with PRPs when administered in ARCRs with a single-row technique. Chen *et al*[42] (2019) performed another higher quality meta-analysis (involving 18 level 1 studies) and concluded that long-term re-tear rates were significantly improved with PRP therapy. Additionally, the functional outcome scores (Constant score, UCLA score - at long- and short-terms) and VAS scores were better in the PRP-treated group. They also performed detailed sub-group analysis in 3 different categories and concluded that: a. Functional outcome measures were more significantly improved when multiple tendons were torn or ruptured, b. Leukocyte-rich PRP (LR-PRP) group had much better improvement in Constant scores as compared with LP-PRP, and c. Patients receiving gel-preparations of PRP had significantly greater Constant scores than their respective comparison groups. They also assessed the minimal clinically important differences (MCID) for these patient-related outcome (PRO) measures. It was concluded that although significant improvements were observed in multiple functional outcome measures in the PRP-treated patient group, none reached their respective MCID. They opined that despite a reasonable number of publications on this subject, limited data availability, substantial study heterogeneity and poor methodological quality hampered our ability to reach firm conclusions regarding PRPs.

Recent meta-analyses and their observations

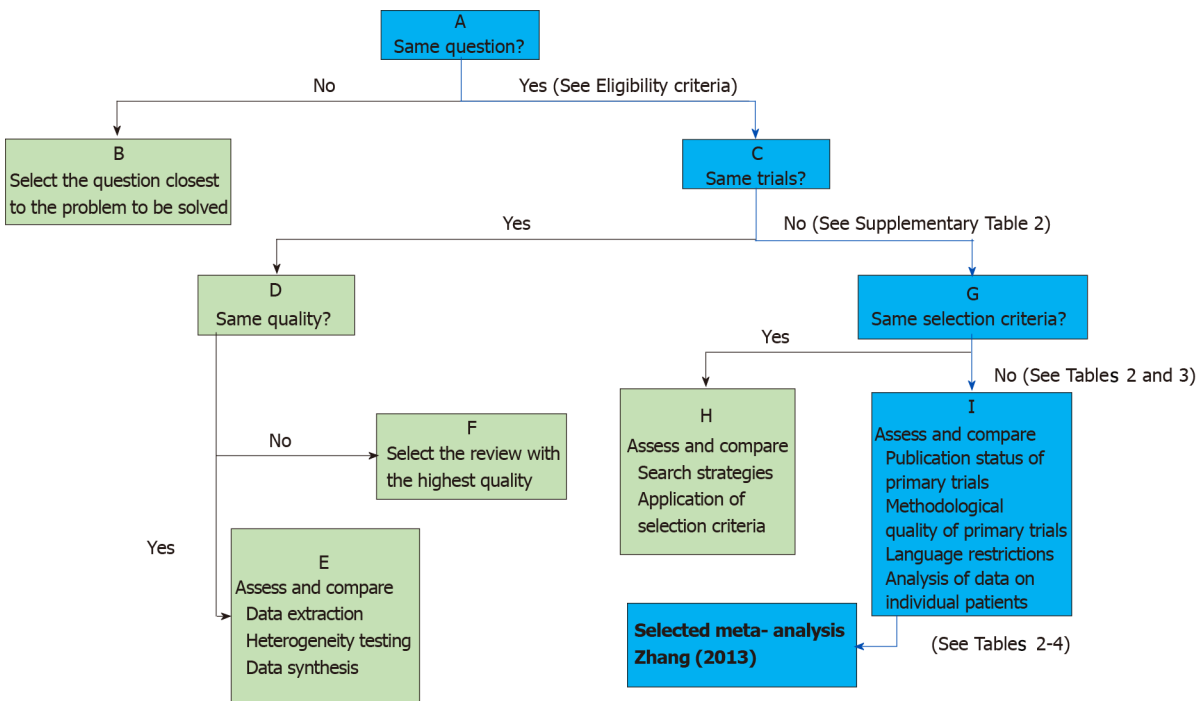
Between 2020 and 2021, 7 new meta-analyses have been published on this topic. Owing to the availability of better quality, larger-scale RCTs over the recent years, these recent meta-analyses have been able to put forth stronger recommendations regarding the administration of PRPs. Cavendish *et al* [43] reported 16 RCTs and prospective trials (1045 participants), Hurley *et al*[44] included 13 RCTs (868 participants), Yang *et al*[45] analyzed 7 RCTs published between 2013 and 2018 (541 participants), Zhao *et al*[46] involved 10 RCTs (742 participants), Ryan *et al*[1] included 17 RCTs (1104 participants), Li *et al* [47] evaluated 23 RCTs (1440 patients) and Xu *et al*[48] studied 14 RCTs (923 patients). Hurley *et al*[44] analyzed RCTs comparing LP- or LR-PRP against controls, Zhao *et al*[46] evaluated studies involving LP-PRP, Ryan *et al*[1] evaluated 4 different types of PRPs (pure platelet-rich plasma [P-PRP], leukocyte and platelet-rich plasma, pure platelet-rich fibrin, and leukocyte and platelet-rich fibrin); and Li *et al*[47] analyzed RCTs comparing PRP or PRF to controls in ARCR. The remaining 3 studies included all RCTs evaluating the overall role of PRPs (with or without comparison to a control group)[43,45,48].

All the 7 recent meta-analyses support the role of PRPs in ARCR. Overall, based on their recommendations, PRPs are preferably delivered intra-operatively at the bone-tendon interface for the best possible outcome. Cavendish *et al*[43] reported that PRPs significantly reduce the failure rates after ARCR, irrespective of the size of tear. Xu *et al*[48] demonstrated substantially improved re-tear rates following intra-operative use of PRP in large- or massive-sized tears. Hurley *et al*[44] concluded that LP-PRP reduces re-tear, enhances healing potential and improves PRO, as compared with a control. Nevertheless, they could not make any strong recommendations regarding its superiority or inferiority as a biological augment, in comparison with LR-PRPs. Even in the meta-analysis by Zhao *et al*[46], LP-PRP was demonstrated to significantly reduce medium- and long-term post-operative re-tear rates in patients undergoing ARCR, irrespective of the size of tear and the technique of repair. Nevertheless, when defined in terms of MCID, the use of LP-PRP failed to reveal any clinically meaningful benefits in terms of post-operative VAS and PRO measures. Among the 4 different types of PRP employed, only P-



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Figure 2 Pooled results of each included meta-analyses along with their heterogeneity. ASES: American Shoulder and Elbow Surgeons; DASH: Disabilities of the Arm, Shoulder and Hand; SST: Simple Shoulder Test; UCLA: University of California Los Angeles; VAS: Visual analog scale.



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Figure 3 Flowchart of Jadad decision algorithm.

PRP demonstrated statistically significant improvement in re-tear rate and Constant score. Theoretically, LP-PRP enhances the formation of normal collagen and mitigates the synthesis of inflammatory mediators. On the other hand, LR-PRP augments the cell catabolism and inflammatory response, both of which are not conducive for tendon healing. Therefore, in acute traumatic RC tears, use of LR-PRP may

Table 6 Systematic Reviews or Meta-analyses with their level of evidence with the authors' rationale for repeating the systematic review along with their concluding remarks

Sl. No.	Ref.	Date of publication	Date of last literature search	Level of evidence	Rationale for repeating meta-analysis	Conclusion
1	Chahal <i>et al</i> [32], 2012	June 14, 2012	December 30, 2011	III	Earliest meta-analysis	No effect of PRP on overall retear rates or shoulder-specific outcomes after ARCR
2	Moraes <i>et al</i> [31], 2013	December 23, 2013	March 25, 2013	I	Only included studies with intra-operative PRP application after ARCR	Some benefit of PRP in improving pain with comparable rates of retear (after 2 yr) between PRP and non-PRP groups
3	Zhang <i>et al</i> [30], 2013	July 12, 2013	April 20, 2013	I	Included studies with high methodological quality and provided results without significant heterogeneity supported by larger number of patients	No benefit of PRP on overall clinical outcomes and retear rate in full-thickness rotator cuff tears and decrease in rate of retears with PRP for small- and medium-sized rotator cuff tear
4	Li <i>et al</i> [33], 2014	June 7, 2014	May 1, 2013	II	All high-quality (7 studies) RCTs included (compared with previous studies)	No benefit with PRP regarding retear and clinical outcomes for ARCR
5	Zhao <i>et al</i> [29], 2014	September 30, 2014	September, 2013	I	Newer RCTs as compared with previous meta-analysis	No benefit of PRP in ARCR of full-thickness tears in terms of similar retear rates and clinical outcomes
6	Warth <i>et al</i> [35], 2014	September 13, 2014	September, 2013	II	Meta-regression analyses to evaluate the effects of 6 covariates such as inclusion of Level II studies, initial tear size, single- <i>vs</i> double-row repair constructs, varying PRP preparation, manual <i>vs</i> commercially available PRP preparation systems, method of PRP application on overall clinical and structural outcomes	No statistically significant differences in outcome scores or retear rate with the use of PRP. However, significant improvement in Constant scores when PRPs applied at tendon-bone interface and significant reduction in retear rate with PRP in tears > 3 cm repaired with double-row technique
7	Vavken <i>et al</i> [36], 2015	March 12, 2015	August 1, 2014	I	To know if addition of PRP to ARCR results in statistically relevant as well as clinically meaningful reduction in retear rates along with analysis of its safety with difference in complication rates and its cost-effectiveness	PRP proved to be an effective and safe way of reducing retear rates in the arthroscopic repair of small- and medium-sized rotator cuff tears. However, no evidence to support its use in large and massive tear
8	Cai <i>et al</i> [38], 2015	October 8, 2015	January, 2015	I	Meta-analysis of level I studies	PRP in full-thickness rotator cuff repairs showed no statistically significant difference in clinical outcome but demonstrated significant reduction in failure-to-heal rate for small-to-moderate tears
9	Xiao <i>et al</i> [37], 2016	October 30, 2016	February 1, 2016	II	All level I and II evidence studies – included to enhance power of meta-analysis (15 studies)	No significant difference in the re-tear rates and clinical efficacy
10	Hurley <i>et al</i> [40], 2018	February 21, 2018	March 24, 2017	I	First study to find that PRP was associated with significant improvement in tendon healing rates in tears > 3 cm with 9 new studies that have been published till Cai <i>et al</i> [38], 2015	Use of PRP in rotator cuff repair improves the healing rates, pain levels, and functional outcomes. But PRF shows no benefit in improving tendon healing rates or functional outcomes
11	Han <i>et al</i> [39], 2019	June 20, 2019	September, 2016	I	Inclusion of new RCTs, as compared with previous meta-analysis with improved pooled effect size	PRP treatment with ARCR showed decreases retear rate and improves clinical outcome
12	Wang <i>et al</i> [41], 2019	July 29, 2019	September 15, 2018	I	To ensure homogeneity of data, only studies using PRP in full-thickness tears included along with addition of new high-level RCTs	PRP improved the short-term outcomes such as pain, retear rate, and shoulder function after ARCR in full-thickness rotator cuff tears. PRP when used in single-row fixation of ARCR demonstrated improved clinical outcomes.
13	Chen <i>et al</i> [42], 2019	September 19, 2019	December, 2017	I	Exclusively reviewed only level 1 RCTs with multiple sub-groups, and comparative quantitative analysis with MCID on effects of LR-PRP <i>vs</i> LP-PRP, gel <i>vs</i> non-gel preparations, and tendon-specific outcomes analyzed	Long-term retear significantly decreased with PRP. Several PROs such as constant score, VAS, retear rate significantly improved in PRP-treated patients. However, all analyzed PROs failed to reach the 5% MCID threshold. Hence authors neither recommended nor discouraged the use of PRP for rotator cuff injuries

14	Cavendish <i>et al</i> [43], 2020	May 1, 2020	May 23, 2018	II	Included 7 out of 16 studies published in the past 4 yr with larger sample size to reduce risk of type II error noted in previous studies	Intraoperative use of PRP reduces the failure risk following rotator cuff repair and has a consistent effect regardless of tear size and showed 25% reduction in the overall risk of failure in rotator cuff repairs
15	Hurley <i>et al</i> [44], 2020	July 30, 2020	March, 2020	I	To ascertain whether there is evidence to support the use of LP- or LR-PRP as an adjunct to ARCR	LP-PRP reduces rate of retear and/or incomplete tendon healing after ARCR and improves patient-reported outcomes as compared with control whereas whether LP-PRP improves the tendon healing rate when compared with LR-PRP remained unclear
16	Yang <i>et al</i> [45], 2020	October 14, 2020	February 15, 2020	I	Inclusion of studies that dealt with PRP application on bone-tendon interface only during arthroscopic repair and studies that administered only PRP and not any other platelet-rich matrix to lower bias caused by different materials. All included RCTs were conducted on patients with full thickness rotator cuff tear who received diagnoses based on preoperative MRI or sonography	Application of PRP shown to be beneficial in reducing the retear rate and improving the functional outcomes during the short-term follow-up of single-row repair
17	Zhao <i>et al</i> [46], 2020	November 18, 2020	March, 2020	II	Meta-analysis of level I and II studies based on MCID values to comprehensively assess clinical efficacy of LP-PRP only for ARCR mainly to avoid heterogeneity due to different types of PRP	LP-PRP - significantly reduces the postoperative retear rate in medium and long term regardless of tear size and method used for repair. But no clinically meaningful effects in terms of postoperative pain and patient-reported outcomes were noted
18	Ryan <i>et al</i> [1], 2021	March 17, 2021	June, 2020	I	Involved stratified pooled data on basis of leukocyte concentration, liquid and solid formulation, and all 4 types of PRP (P-PRP, P-PRF, LP-PRP, LP-PRF)	This analysis demonstrates significant reductions in retear when rotator cuff repair is augmented with PRP. LP-PRP appears to be most effective formulation, resulting in significantly improved retear rates and clinical outcome scores when compared with controls
19	Xu <i>et al</i> [48], 2021	May 27, 2021	October 29, 2020	II	Analyzed PRP and PRF separately and PRP was sub grouped into leukocyte-poor and leukocyte-rich PRP. Compared with study by Hurley <i>et al</i> 5 more RCTs included. Cochrane Collaboration risk of bias tool- adopted and retear rate was analyzed based on duration of follow-up into 2 subgroups with a cut off of 2 yr	PRP in ARCR improved pain and functional outcome, reduces retear rates. PRF improved only the Constant score. Significant reduction of retear rate in leukocyte-poor PRP when followed-up > 2 yr
20	Li <i>et al</i> [47], 2021	July 13, 2021	June 20, 2020	I	Strict eligibility criteria enforced in the inclusion of RCTs along with subgroup analysis, based on PRP preparation, time of administration, size of tear, type of repair, to assess the real utility of PRP	ARCR with PRP significantly improved long-term retear, shoulder pain and long-term shoulder function scores and intraoperative application of leukocyte-poor plasma for large to massive tears contributed to significant decrease in retear rates

ARCR: Arthroscopic rotator cuff repair; LP: Leukocyte poor; LP-PRF: Leucocyte poor – platelet rich fibrin; LP-PRP: Leucocyte poor – platelet rich plasma; LR: Leukocyte rich; MCID: Minimum clinically identifiable difference; P-PRF: Pure platelet rich fibrin; P-PRP: Pure platelet rich plasma; PRF: Platelet rich fibrin; PRO: Patient reported outcomes; PRP: Platelet rich plasma; RCTs: Randomized controlled trials.

impair post-operative tissue healing. These recent meta-analyses also seem to indicate the superiority of LP-PRP (over LR-PRP) in ARCR[48]. Thus, despite multiple studies published on this topic, the literature is still unclear on whether the use of PRP is more beneficial in massive and full-thickness tears or smaller and partial thickness injuries[36,38,44,48]. A majority of the studies in the literature have also not clearly determined the correlation between the type of RC repair and the effect of PRP application [29-40,42-48]. However, two recent studies [Wang *et al*[41] (2019) and Yang *et al*[45] (2020)] have shown better outcome with PRP use following single-row RC repairs[6,41].

These recent studies have also cautioned regarding significant heterogeneity in the available preparations of PRPs, which leads to inconsistent outcome and difficulty in making strong recommendations in favor or against this treatment modality. Yang *et al*[45] demonstrated a significant decrease in re-tears as well as a substantial improvement in short-term pain severity (VAS) and short-term functional outcome (Constant and UCLA scores). In a sub-group analysis, they also demonstrated meliorated outcomes (in terms of VAS, functional scores and re-tear) in both single- and double-row repair groups. In a comparison study by Li *et al*[47] between PRP and PRF, PRP demonstrated significant improvement in pain, functional outcome and re-tears; while PRF only improved Constant score.

Directions for future

Although PRP has been considered as a minimally-invasive effective non-operative treatment methodology for partial RC tears[50], its utility as an adjuvant in the ARCR needs further refinement to preclude the heterogeneity in the results obtained and achieve consistent beneficial effects of the additive intervention performed. For example, role of repeat administration of PRP and utility of scaffolds as a medium of sustained delivery of the growth factors from the platelet concentrate may provide even more beneficial effects compared to the single direct use post-ARCR[51]. Although our systematic overview establishes the efficacy of PRP as an adjuvant to ARCR, there remains heterogeneity among the study results obtained due to the variability in the preparation and the utility of PRP. To clarify these aspects, blinded RCTs investigating the above-mentioned lacunae are required in the future.

Limitations

This study has some limitations. The quality of the meta-analyses identified in our study were of Level I/II evidence due to the quality of the included primary studies in them. Hence, we were unable to provide a level I recommendation on the utility of PRP in ARCR with the existing literature. This systematic overview may be influenced by the limitations and biases involved in the meta-analyses and their primary studies. Moreover, selecting the meta-analysis of highest quality based on the Jadad algorithm generates recommendations based on the results of the selected meta-analysis at the cost of studies missed from their primary search as highlighted in [Supplementary Table 1](#). Moreover, we identified many recent meta-analyses, apart from the meta-analysis selected through the Jadad algorithm, which had the power of the recent RCTs on the subject. Hence, we resorted to give collaborative documentation based on all the recent evidence though they lack the methodological robustness of the study identified by the Jadad algorithm thereby making the final level of recommendation that was achieved out of this study to be Level II. Heterogeneity was noted across the studies in terms of their methods of preparation, use of activators and method of application of PRP which could have accounted for the variability noted across the primary studies and the meta-analyses that included them into analysis.

CONCLUSION

Based on our systematic overview of the existing meta-analyses, we could observe that despite multiple publications on this subject over the past years, methodological quality of the included studies and heterogeneity in protocols employed across different individual trials continue to remain major impediments in clearly defining the role of PRPs in ARCR. Nevertheless, the recent meta-analysis published over the past 2 years to 3 years seems to indicate a clear benefit of intra-operative use of PRPs at the bone-tendon interface in terms of post-operative pain, functional outcome and re-tear rates (irrespective of the type of repair performed). Although the older studies supported its role in only small to moderate tears, recent studies indicate a definite benefit in tears of all sizes (including massive ones). Among the different preparations used, LP-PRP possibly offers the greatest benefit as a biological augment in these situations.

ARTICLE HIGHLIGHTS

Research background

Platelet-rich plasma has been gaining popularity as an agent for biological augmentation either as the sole treatment modality or as an adjunct to surgical repair.

Research motivation

There is growing evidence on the positive effects of platelet-derived autologous growth factors on collagen production, cell proliferation, tissue revascularization and tendon regeneration thereby making them useful as an augment to arthroscopic rotator cuff repair.

Research objectives

The overall purpose of the current study was to perform a detailed systematic review of the existing meta-analyses evaluating the role of PRP in patients undergoing rotator cuff repair; and to specifically provide answers to the following research questions, namely: (1) To evaluate the effect of this strategy on overall clinical outcome scores; (2) To evaluate the reduction in re-tear or failure rates; (3) To analyze the evolution and variations in the techniques of procurement and application of PRP across different studies; (4) To critically analyze and interpret the best currently available evidence and provide recommendations; and (5) To discern the major gaps in the existing literature and identify the scope for

future research on this subject.

Research methods

We then utilized the Jadad decision algorithm to identify the study with the highest quality to represent the current best evidence to generate the recommendation.

Research results

Recent meta-analyses are more supportive of the role of intra-operative administration of PRPs at the bone-tendon interface in improving the overall healing and re-tear rates, functional outcome and pain. The initial size of the tear and type of repair performed do not seem to affect the benefit of PRPs. Among the different preparations used, leucocyte poor (LP)-PRP possibly offers the greatest benefit as a biological augment in these situations.

Research conclusions

Based on this systematic overview, we give a Level II recommendation that intra-operative use of PRPs at the bone-tendon interface can augment the healing rate, reduce re-tears, enhance functional outcome and mitigate pain in patients undergoing arthroscopic rotator cuff repair.

Research perspectives

LP-PRP possibly offers the greatest benefit in terms of healing rates as compared with other platelet preparations.

FOOTNOTES

Author contributions: Muthu S conducted the research along with Viswanathan VK, Jeyaraman N, Patel K, Chellamuthu G, Jeyaraman M and Khanna M helped in the conduction of the study; All authors have read and approved the final manuscript.

Conflict-of-interest statement: None of the authors have a conflict of interest over the subject presented.

PRISMA 2009 Checklist statement: The authors have read the PRISMA 2009 Checklist, and the manuscript was prepared and revised according to the PRISMA 2009 Checklist.

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S-Editor: Liu JH

L-Editor: Filipodia

P-Editor: Liu JH

REFERENCES

- 1 **Ryan J**, Imbergamo C, Sudah S, Kirchner G, Greenberg P, Monica J, Gatt C. Platelet-Rich Product Supplementation in Rotator Cuff Repair Reduces Retear Rates and Improves Clinical Outcomes: A Meta-analysis of Randomized Controlled Trials. *Arthroscopy* 2021; **37**: 2608-2624 [PMID: 33744318 DOI: 10.1016/j.arthro.2021.03.010]
- 2 **Boileau P**, Brassart N, Watkinson DJ, Carles M, Hatzidakis AM, Krishnan SG. Arthroscopic repair of full-thickness tears of the supraspinatus: does the tendon really heal? *J Bone Joint Surg Am* 2005; **87**: 1229-1240 [PMID: 15930531 DOI: 10.2106/JBJS.D.02035]
- 3 **Franceschi F**, Ruzzini L, Longo UG, Martina FM, Zobel BB, Maffulli N, Denaro V. Equivalent clinical results of arthroscopic single-row and double-row suture anchor repair for rotator cuff tears: a randomized controlled trial. *Am J Sports Med* 2007; **35**: 1254-1260 [PMID: 17554104 DOI: 10.1177/0363546507302218]
- 4 **Grasso A**, Milano G, Salvatore M, Falcone G, Deriu L, Fabbriani C. Single-row versus double-row arthroscopic rotator cuff repair: a prospective randomized clinical study. *Arthroscopy* 2009; **25**: 4-12 [PMID: 19111212 DOI: 10.1016/j.arthro.2008.09.018]

- 5 **Sugaya H**, Maeda K, Matsuki K, Moriishi J. Repair integrity and functional outcome after arthroscopic double-row rotator cuff repair. A prospective outcome study. *J Bone Joint Surg Am* 2007; **89**: 953-960 [PMID: [17473131](#) DOI: [10.2106/JBJS.F.00512](#)]
- 6 **Saltzman BM**, Jain A, Campbell KA, Mascarenhas R, Romeo AA, Verma NN, Cole BJ. Does the Use of Platelet-Rich Plasma at the Time of Surgery Improve Clinical Outcomes in Arthroscopic Rotator Cuff Repair When Compared With Control Cohorts? *Arthroscopy* 2016; **32**: 906-918 [PMID: [26725454](#) DOI: [10.1016/j.arthro.2015.10.007](#)]
- 7 **P B**, E W, A N, M K, T M, S D, W M. Microcirculation associated with degenerative rotator cuff lesions. In vivo assessment with orthogonal polarization spectral imaging during arthroscopy of the shoulder. *J Bone Joint Surg Am* 2003; **85** Accessed 26 November 2021. Available from: <https://pubmed.ncbi.nlm.nih.gov/12637434/>
- 8 **Thomopoulos S**, Williams GR, Soslowky LJ. Tendon to bone healing: differences in biomechanical, structural, and compositional properties due to a range of activity levels. *J Biomech Eng* 2003; **125**: 106-113 [PMID: [12661203](#) DOI: [10.1115/1.1536660](#)]
- 9 **Fealy S**, Adler RS, Drakos MC, Kelly AM, Allen AA, Cordasco FA, Warren RF, O'Brien SJ. Patterns of vascular and anatomical response after rotator cuff repair. *Am J Sports Med* 2006; **34**: 120-127 [PMID: [16260468](#) DOI: [10.1177/0363546505280212](#)]
- 10 **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; **20**: 518-528 [PMID: [21570659](#) DOI: [10.1016/j.jse.2011.02.008](#)]
- 11 **Castricini R**, Longo UG, De Benedetto M, Panfoli N, Pirani P, Zini R, Maffulli N, Denaro V. Platelet-rich plasma augmentation for arthroscopic rotator cuff repair: a randomized controlled trial. *Am J Sports Med* 2011; **39**: 258-265 [PMID: [21160018](#) DOI: [10.1177/0363546510390780](#)]
- 12 **Gulotta LV**, Kovacevic D, Ehteshami JR, Dagher E, Packer JD, Rodeo SA. Application of bone marrow-derived mesenchymal stem cells in a rotator cuff repair model. *Am J Sports Med* 2009; **37**: 2126-2133 [PMID: [19684297](#) DOI: [10.1177/0363546509339582](#)]
- 13 **Bielecki T**, Dohan Ehrenfest DM. Platelet-rich plasma (PRP) and Platelet-Rich Fibrin (PRF): surgical adjuvants, preparations for in situ regenerative medicine and tools for tissue engineering. *Curr Pharm Biotechnol* 2012; **13**: 1121-1130 [PMID: [21740380](#) DOI: [10.2174/138920112800624292](#)]
- 14 **Malavolta EA**, Gracitelli ME, Ferreira Neto AA, Assunção JH, Bordalo-Rodrigues M, de Camargo OP. Platelet-rich plasma in rotator cuff repair: a prospective randomized study. *Am J Sports Med* 2014; **42**: 2446-2454 [PMID: [25086065](#) DOI: [10.1177/0363546514541777](#)]
- 15 **Bava ED**, Barber FA. Platelet-rich plasma products in sports medicine. *Phys Sportsmed* 2011; **39**: 94-99 [PMID: [22030945](#) DOI: [10.3810/psm.2011.09.1925](#)]
- 16 **Beitzel K**, Allen D, Apostolakis J, Russell RP, McCarthy MB, Gallo GJ, Cote MP, Mazzocca AD. US definitions, current use, and FDA stance on use of platelet-rich plasma in sports medicine. *J Knee Surg* 2015; **28**: 29-34 [PMID: [25268794](#) DOI: [10.1055/s-0034-1390030](#)]
- 17 **Furlan AD**, Malmivaara A, Chou R, Maher CG, Deyo RA, Schoene M, Bronfort G, van Tulder MW; Editorial Board of the Cochrane Back, Neck Group. 2015 Updated Method Guideline for Systematic Reviews in the Cochrane Back and Neck Group. *Spine (Phila Pa 1976)* 2015; **40**: 1660-1673 [PMID: [26208232](#) DOI: [10.1097/BRS.0000000000001061](#)]
- 18 **Moher D**, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009; **6**: e1000097 [PMID: [19621072](#) DOI: [10.1371/journal.pmed.1000097](#)]
- 19 **McGowan J**, Sampson M, Salzwedel DM, Cogo E, Foerster V, Lefebvre C. PRESS Peer Review of Electronic Search Strategies: 2015 Guideline Statement. *J Clin Epidemiol* 2016; **75**: 40-46 [PMID: [27005575](#) DOI: [10.1016/j.jclinepi.2016.01.021](#)]
- 20 **Slobogean G**, Bhandari M. Introducing levels of evidence to the Journal of Orthopaedic Trauma: implementation and future directions. *J Orthop Trauma* 2012; **26**: 127-128 [PMID: [22330974](#) DOI: [10.1097/BOT.0b013e318247c931](#)]
- 21 **Shea BJ**, Grimshaw JM, Wells GA, Boers M, Andersson N, Hamel C, Porter AC, Tugwell P, Moher D, Bouter LM. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Med Res Methodol* 2007; **7**: 10 [PMID: [17302989](#) DOI: [10.1186/1471-2288-7-10](#)]
- 22 **Shea BJ**, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, Moher D, Tugwell P, Welch V, Kristjansson E, Henry DA. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ* 2017; **358**: j4008 [PMID: [28935701](#) DOI: [10.1136/bmj.j4008](#)]
- 23 **Sathish M**, Eswar R. Systematic Reviews and Meta-Analysis in Spine Surgery-How Good Are They in Methodological Quality? *Global Spine J* 2021; **11**: 378-399 [PMID: [32875866](#) DOI: [10.1177/2192568220906810](#)]
- 24 **Higgins JP**, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ* 2003; **327**: 557-560 [PMID: [12958120](#) DOI: [10.1136/bmj.327.7414.557](#)]
- 25 **Jadad AR**, Cook DJ, Browman GP. A guide to interpreting discordant systematic reviews. *CMAJ* 1997; **156**: 1411-1416 [PMID: [9164400](#)]
- 26 **Ding F**, Jia Z, Zhao Z, Xie L, Gao X, Ma D, Liu M. Total disc replacement versus fusion for lumbar degenerative disc disease: a systematic review of overlapping meta-analyses. *Eur Spine J* 2017; **26**: 806-815 [PMID: [27448810](#) DOI: [10.1007/s00586-016-4714-y](#)]
- 27 **Fu BS**, Jia HL, Zhou DS, Liu FX. Surgical and Non-Surgical Treatment for 3-Part and 4-Part Fractures of the Proximal Humerus: A Systematic Review of Overlapping Meta-Analyses. *Orthop Surg* 2019; **11**: 356-365 [PMID: [31207136](#) DOI: [10.1111/os.12486](#)]
- 28 **Mascarenhas R**, Chalmers PN, Sayegh ET, Bhandari M, Verma NN, Cole BJ, Romeo AA. Is double-row rotator cuff repair clinically superior to single-row rotator cuff repair: a systematic review of overlapping meta-analyses. *Arthroscopy* 2014; **30**: 1156-1165 [PMID: [24821226](#) DOI: [10.1016/j.arthro.2014.03.015](#)]
- 29 **Zhao Y**, Yang S, Ding W. Unilateral versus bilateral pedicle screw fixation in lumbar fusion: A systematic review of overlapping meta-analyses. *PLoS One* 2019; **14**: e0226848 [PMID: [31860651](#) DOI: [10.1371/journal.pone.0226848](#)]
- 30 **Zhang Q**, Ge H, Zhou J, Cheng B. Are platelet-rich products necessary during the arthroscopic repair of full-thickness

- rotator cuff tears: a meta-analysis. *PLoS One* 2013; **8**: e69731 [PMID: 23874991 DOI: 10.1371/journal.pone.0069731]
- 31 **Moraes VY**, Lenza M, Tamaoki MJ, Faloppa F, Belloti JC. Platelet-rich therapies for musculoskeletal soft tissue injuries. *Cochrane Database Syst Rev* 2014; CD010071 [PMID: 24782334 DOI: 10.1002/14651858.CD010071.pub3]
- 32 **Chahal J**, Van Thiel GS, Mall N, Heard W, Bach BR, Cole BJ, Nicholson GP, Verma NN, Whelan DB, Romeo AA. The role of platelet-rich plasma in arthroscopic rotator cuff repair: a systematic review with quantitative synthesis. *Arthroscopy* 2012; **28**: 1718-1727 [PMID: 22694941 DOI: 10.1016/j.arthro.2012.03.007]
- 33 **Li X**, Xu CP, Hou YL, Song JQ, Cui Z, Yu B. Are platelet concentrates an ideal biomaterial for arthroscopic rotator cuff repair? *Arthroscopy* 2014; **30**: 1483-1490 [PMID: 24913394 DOI: 10.1016/j.arthro.2014.03.020]
- 34 **Zhao JG**, Zhao L, Jiang YX, Wang ZL, Wang J, Zhang P. Platelet-rich plasma in arthroscopic rotator cuff repair: a meta-analysis of randomized controlled trials. *Arthroscopy* 2015; **31**: 125-135 [PMID: 25278352 DOI: 10.1016/j.arthro.2014.08.008]
- 35 **Warth RJ**, Dornan GJ, James EW, Horan MP, Millett PJ. Clinical and structural outcomes after arthroscopic repair of full-thickness rotator cuff tears with and without platelet-rich product supplementation: a meta-analysis and meta-regression. *Arthroscopy* 2015; **31**: 306-320 [PMID: 25450417 DOI: 10.1016/j.arthro.2014.09.007]
- 36 **Vavken P**, Sadoghi P, Palmer M, Rosso C, Mueller AM, Szoelloesy G, Valderrabano V. Platelet-Rich Plasma Reduces Retear Rates After Arthroscopic Repair of Small- and Medium-Sized Rotator Cuff Tears but Is Not Cost-Effective. *Am J Sports Med* 2015; **43**: 3071-3076 [PMID: 25767267 DOI: 10.1177/0363546515572777]
- 37 **Xiao W**, Luo R, Sun J, Chen J, Ma Q, Cai X, Liu P. Efficacy and clinical outcomes of platelet-rich plasma for arthroscopic repair rotator cuff tears: a meta-analysis, 10
- 38 **Cai YZ**, Zhang C, Lin XJ. Efficacy of platelet-rich plasma in arthroscopic repair of full-thickness rotator cuff tears: a meta-analysis. *J Shoulder Elbow Surg* 2015; **24**: 1852-1859 [PMID: 26456434 DOI: 10.1016/j.jse.2015.07.035]
- 39 **Han C**, Na Y, Zhu Y, Kong L, Eerdun T, Yang X, Ren Y. Is platelet-rich plasma an ideal biomaterial for arthroscopic rotator cuff repair? *J Orthop Surg Res* 2019; **14**: 183 [PMID: 31221198 DOI: 10.1186/s13018-019-1207-9]
- 40 **Hurley ET**, Lim Fat D, Moran CJ, Mullett H. The Efficacy of Platelet-Rich Plasma and Platelet-Rich Fibrin in Arthroscopic Rotator Cuff Repair: A Meta-analysis of Randomized Controlled Trials. *Am J Sports Med* 2019; **47**: 753-761 [PMID: 29466688 DOI: 10.1177/0363546517751397]
- 41 **Wang C**, Xu M, Guo W, Wang Y, Zhao S, Zhong L. Clinical efficacy and safety of platelet-rich plasma in arthroscopic full-thickness rotator cuff repair: A meta-analysis. *PLoS One* 2019; **14**: e0220392 [PMID: 31356630 DOI: 10.1371/journal.pone.0220392]
- 42 **Chen XT**, Jones IA, Park C, Vangsness CT Jr. Use of Platelet-Rich Plasma for the Improvement of Pain and Function in Rotator Cuff Tears: Response. *Am J Sports Med* 2020; **48**: NP39-NP41 [PMID: 32352334 DOI: 10.1177/0363546520918190]
- 43 **Cavendish PA**, Everhart JS, DiBartola AC, Eikenberry AD, Cvetanovich GL, Flanigan DC. The effect of perioperative platelet-rich plasma injections on postoperative failure rates following rotator cuff repair: a systematic review with meta-analysis. *J Shoulder Elbow Surg* 2020; **29**: 1059-1070 [PMID: 32305103 DOI: 10.1016/j.jse.2020.01.084]
- 44 **Hurley ET**, Colasanti CA, Anil U, Luthringer TA, Alaia MJ, Campbell KA, Jazrawi LM, Strauss EJ. The Effect of Platelet-Rich Plasma Leukocyte Concentration on Arthroscopic Rotator Cuff Repair: A Network Meta-analysis of Randomized Controlled Trials. *Am J Sports Med* 2021; **49**: 2528-2535 [PMID: 33332160 DOI: 10.1177/0363546520975435]
- 45 **Yang FA**, Liao CD, Wu CW, Shih YC, Wu LC, Chen HC. Effects of applying platelet-rich plasma during arthroscopic rotator cuff repair: a systematic review and meta-analysis of randomised controlled trials. *Sci Rep* 2020; **10**: 17171 [PMID: 33057143 DOI: 10.1038/s41598-020-74341-0]
- 46 **Zhao D**, Han YH, Pan JK, Yang WY, Zeng LF, Liang GH, Liu J. The clinical efficacy of leukocyte-poor platelet-rich plasma in arthroscopic rotator cuff repair: a meta-analysis of randomized controlled trials. *J Shoulder Elbow Surg* 2021; **30**: 918-928 [PMID: 33220417 DOI: 10.1016/j.jse.2020.10.014]
- 47 **Li Y**, Li T, Li J, Tang X, Li R, Xiong Y. Platelet-Rich Plasma Has Better Results for Retear Rate, Pain, and Outcome Than Platelet-Rich Fibrin After Rotator Cuff Repair: A Systematic Review and Meta-analysis of Randomized Controlled Trials. *Arthroscopy* 2022; **38**: 539-550 [PMID: 34052384 DOI: 10.1016/j.arthro.2021.05.023]
- 48 **Xu W**, Xue Q. Application of Platelet-Rich Plasma in Arthroscopic Rotator Cuff Repair: A Systematic Review and Meta-analysis. *Orthop J Sports Med* 2021; **9**: 23259671211016847 [PMID: 34345632 DOI: 10.1177/23259671211016847]
- 49 **Moja L**, Fernandez del Rio MP, Banzi R, Cusi C, D'Amico R, Liberati A, Lodi G, Lucenteforte E, Minozzi S, Pecoraro V, Virgili G, Parmelli E. Multiple systematic reviews: methods for assessing discordances of results. *Intern Emerg Med* 2012; **7**: 563-568 [PMID: 22941412 DOI: 10.1007/s11739-012-0846-1]
- 50 **El Gharbawy NH**, Labib HS. Role of Platelet Rich Plasma (PRP) injection in treatment of rotator cuff tear. *Egyptian Rheumatology and Rehabilitation* 2020; **47**: 30 [DOI: 10.1186/s43166-020-00032-3]
- 51 **Hitchen J**, Wragg NM, Shariatzadeh M, Wilson SL. Platelet Rich Plasma as a Treatment Method for Rotator Cuff Tears. *SN Compr Clin Med* 2020; **2**: 2293-2299 [DOI: 10.1007/s42399-020-00500-z]



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