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Therapeutic interventions of platelet-rich plasma versus corticosteroid injections for lumbar radicular pain: a systematic review and meta-analysis

Xinan Wang[1] and Ying Zhang[2*]

Abstract

Objective Although epidural corticosteroid injections (ESIs) provide short-term relief for lumbar radicular pain caused by disc herniation, concerns remain regarding their long-term efficacy and complications. Platelet-rich plasma (PRP), with its dual anti-inflammatory and regenerative properties, is a promising alternative, but the comparative evidence between the two treatments remains inconclusive.

Methods A systematic search was conducted in PubMed, Embase, Web of Science, and the Cochrane Library, with a cutoff date of January 10, 2025. The primary outcomes were the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) scores. The risk of bias in the included studies was assessed using Cochrane ROB and ROBINS-I. The primary outcome measures were analyzed by evaluating standardized mean differences (SMDs).

Results A total of seven studies (four randomized controlled trials and three prospective studies) were included in the meta-analysis, comprising 416 patients. The results indicated that corticosteroids significantly reduced ODI scores at the initial follow-up (4 weeks) (SMD = 0.48, 95% CI: 0.20 to 0.75, $p = 0.0008$, $I^2 = 15\%$), with no significant differences observed in VAS and ODI scores between the two groups at other time points. The complication rates for the PRP and corticosteroid groups were reported, with no severe adverse events reported.

Conclusions Compared to PRP, corticosteroid injections showed significant early functional improvements in patients. Although no significant differences in pain and functional improvements were observed between the PRP and corticosteroid groups at other follow-up time points, future studies are needed to assess the efficacy and safety of PRP versus corticosteroid injections in treating lumbar radicular pain by standardizing PRP preparation, extending follow-up durations, and increasing sample sizes.

Keywords Platelet-rich plasma, Corticosteroid, Lumbar radicular pain, Clinical efficacy, Therapeutic intervention, Meta-analysis

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Introduction

Lumbar radicular pain, a hallmark symptom of degenerative spinal disorders, arises from mechanical compression of nerve roots and the release of inflammatory mediators [1, 2]. Its characteristic clinical presentation includes radiating pain (electric-shock-like or burning sensation) along the distribution of the affected nerve root, often accompanied by sensory deficits and diminished reflexes [3, 4]. Epidemiological studies indicate that lumbar disc herniation is the primary etiology of radicular pain in individuals aged 22–55 years, with a higher prevalence in males and predominant involvement at the L4-L5 and L5-S1 spinal segments [5, 6].

The management of lumbar radicular pain encompasses surgical and non-surgical interventions. While surgery (e.g., discectomy) is unequivocally indicated for neurological deficits secondary to cauda equina syndrome [7, 8], most cases are managed non-surgically. Current non-operative approaches include pharmacological analgesia (NSAIDs, opioids), physical therapy, and psychological interventions, though their efficacy is limited by side effects (e.g., drug dependency) and patient adherence [9]. In this context, epidural corticosteroid injections (ESIs) have become a pivotal intervention for refractory radicular pain over the past three decades, owing to their targeted anti-inflammatory properties [10–12]. Their primary mechanisms include inflammation suppression, pain alleviation, and functional improvement. Corticosteroid injections are administered via three routes: interlaminar, transforaminal, and caudal [13]. The transforaminal approach is more effective than other methods because it enables precise delivery to target structures, such as the spinal nerve, anterior epidural space, and dorsal root ganglion. This targeted delivery helps reduce inflammation caused by nerve root compression [14]. A previous randomized controlled trials (RCT) reported a success rate of up to 84% for transforaminal ESIs in managing lumbosacral radicular pain over a 1.4-year follow-up period [15]. However, a meta-analysis revealed that while transforaminal ESIs provide significant analgesic effects at 3 months, they fail to improve physical disability in patients with lumbosacral radicular pain [16]. Furthermore, ESIs carry potential risks such as infection, hyperglycemia, and epidural lipomatosis, with cautious application required in patients with comorbid diabetes mellitus or osteoporosis [17].

In recent years, platelet-rich plasma (PRP) has garnered significant attention due to its dual mechanisms of action: anti-inflammatory effects and tissue regeneration [18, 19]. PRP exerts its therapeutic effects by releasing cytokines and growth factors (such as interleukin-1 receptor antagonist (IL-1Ra), transforming growth factor-beta 1 (TGF-β1), and platelet-derived growth factor (PDGF)), which suppress inflammatory cascades around nerve roots while promoting repair of damaged ligaments and annulus fibrosus [20]. Clinical studies have demonstrated sustained efficacy of PRP in osteoarthritis management at mid- to long-term follow-ups (e.g., 6- and 12-month intervals) [21, 22]. In a single-center prospective study, Le et al. [23] reported that transforaminal autologous PRP injections alleviated chronic pain in patients, with no treatment-related complications observed during a 12-month follow-up. Singla et al. [24] compared corticosteroids with PRP for sacroiliac joint pain and found that PRP significantly improved pain outcomes at 4 weeks and 3 months post-treatment. Growing clinical evidence suggests that PRP may serve as a promising alternative to epidural corticosteroids for lumbar radicular pain [25, 26]. However, evidence-based comparisons between PRP and corticosteroids for lumbar radicular pain remain limited.

This meta-analysis aims to comprehensively compare the clinical efficacy of PRP versus corticosteroid injections in the management of radicular pain, focusing on pain relief and functional recovery. The findings will provide evidence-based guidance for treating lumbar radicular pain and offer scientific insights to optimize clinical treatment strategies.

Materials and methods

Literature search strategy

Two independent investigators conducted a comprehensive search of the following databases: PubMed, Embase, Web of Science, and Cochrane Library. The search timeframe spanned from the inception of each database up to January 10, 2025, and only English-language publications were included. A combination of controlled vocabulary terms (MeSH/Emtree) and free-text keywords was employed, with Boolean operators (AND/OR) used to construct the search syntax. An example search strategy is provided below: ("lumbar radicular pain" OR "lumbar radiculopathy" OR "sciatica" OR "radicular pain" OR "nerve root pain") AND (("platelet-rich plasma" OR "PRP" OR "autologous conditioned plasma") OR ("steroids" OR "glucocorticoids" OR "corticosteroid" OR "epidural steroid")) AND ("randomized controlled trial" OR "controlled clinical trial" OR "cohort studies"). Reference management was performed using EndNote 20 (Clarivate Analytics) with automated duplicate removal. Supplemental manual searches of reference lists ensured search saturation. Discrepancies in search results between the two investigators were resolved through consultation with a third reviewer. This meta-analysis was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [27, 28]. The protocol of this review was prospectively registered on the International Prospective Register

of Systematic Reviews (PROSPERO) with the registration ID: CRD42025649942.

Inclusion and exclusion criteria

Inclusion Criteria

1) Randomized controlled trials (RCTs), cohort studies, or case-control studies comparing platelet-rich plasma (PRP) injections with corticosteroid injections for treating lumbar radicular pain in adults;
2) Study participants aged ≥ 18 years with clinically or radiologically confirmed lumbar nerve root compression (e.g., herniated disc, spinal stenosis) via imaging (e.g., MRI/CT);
3) Intervention group receiving PRP injections (regardless of preparation methods or injection routes), and control group receiving corticosteroid injections (any type or dosage);
4) Studies must report primary outcomes such as pain intensity (e.g., Visual Analog Scale (VAS)) or functional scores (e.g., Oswestry Disability Index (ODI));
5) All included studies must provide post-treatment follow-up data ≥ 4 weeks, and publications must be in English.

Exclusion Criteria

1) Non-lumbar etiologies of pain (e.g., neoplastic, infectious, or traumatic causes);
2) Combined therapies (e.g., PRP administered alongside corticosteroid);
3) Case reports, conference abstracts, reviews, animal studies, in vitro studies, or studies with inaccessible data;
4) Literature that failed to distinctly differentiate therapeutic outcomes between PRP and corticosteroids.

Data extraction and outcome measures

Two reviewers independently extracted data using a standardized form, with discrepancies resolved through discussion with a third reviewer. Extracted data included: (1) Study characteristics: author, country, publication year, and study design; (2) Demographic and clinical data: age, sex, BMI, and involved disc levels; (3) Intervention details: PRP preparation methods, dosage, and injection protocols, as well as the type and dosage of corticosteroid administered.

For outcome measures, primary endpoints focused on pain intensity (VAS) and functional disability (ODI) at follow-up time points of ≥ 4 weeks post-treatment (e.g., 4 weeks, 3 months, and 6 months). Secondary outcomes included adverse events reported after treatment, documenting specific event types and severity levels.

Quality assessment

Given that the included studies comprised 5 randomized controlled trials (RCTs) and 2 non-randomized studies, distinct risk-of-bias assessment tools were applied. For RCTs, the Cochrane Risk of Bias (RoB) tool was used to evaluate five domains: (1) Randomization process (random sequence generation and allocation concealment); (2) Deviations from intended interventions (e.g., blinding of participants/personnel); (3) Missing outcome data (completeness of follow-up); (4) Outcome measurement (blinding of outcome assessors); (5) Selective reporting (consistency between pre-registered protocols and published results). For non-RCTs, the Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool [29] was employed to assess seven domains: (1) Bias due to confounding; (2) Bias in participant selection; (3) Bias in classification of interventions; (4) Bias due to deviations from intended interventions; (5) Bias due to missing data; (6) Bias in outcome measurement; (7) Bias in selective reporting. Final judgments for each domain were categorized as "low risk," "high risk," or "unclear risk." The quality assessment results were visualized using RevMan 5.3.4 (Cochrane Collaboration, Copenhagen, Denmark). Discrepancies between the two investigators were resolved through discussion with a third reviewer.

Statistical analysis

For continuous outcome variables, the standardized mean difference (SMD) with 95% confidence intervals (95% CI) was calculated as the effect measure. Heterogeneity across studies was evaluated using the chi-squared test (significance threshold: $p < 0.10$) and the I^2 statistic. I^2 value ≤ 50% indicated low heterogeneity, and a fixed-effects model was applied; otherwise, a random-effects model was used. Separate meta-analyses were conducted for follow-up time points of 4 weeks, 3 months, and 6 months. Data synthesis and visualization (forest plots) were performed using RevMan 5.3.4 (Cochrane Collaboration, Copenhagen, Denmark). A p-value < 0.05 was considered statistically significant.

Results

Literature screening process

A systematic search of PubMed, Embase, Cochrane Library, and Web of Science initially identified 568 articles. After removing duplicates, 420 articles proceeded to initial screening. Based on title and abstract review, 380 clearly irrelevant articles were excluded, leaving 40 studies for full-text evaluation. Following full-text review, 33 articles were excluded for the following reasons: (1) Lack of a direct comparison group between PRP and

corticosteroid injections ($n=17$); (2) Failure to report VAS or ODI score data ($n=9$); (3) Insufficient follow-up duration ($n=5$); (4) Non-English publications ($n=2$). Ultimately, 7 studies [30–36] met the inclusion criteria and were included in the subsequent meta-analysis. The PRISMA flowchart detailing the screening process is presented in Fig. 1.

Characteristics of included studies

Seven studies published between 2020 and 2024 were included, comprising 5 RCTs, 1 prospective non-randomized study, and 1 retrospective cohort study. The total sample size comprised 207 patients in the PRP group and 209 in the corticosteroid group. The studies originated from seven countries, including France, China, Japan, and others. Patient age ranged from 26.4 to 74 years in the PRP group and 22.7 to 66.0 years in the corticosteroid group, with balanced gender distribution (female representation: 33–74% in the PRP group vs. 29–55% in the corticosteroid group). PRP preparation parameters varied significantly: blood collection volume ranged from 18 to 400 mL (median: 26 mL), injected volume ranged from 2 to 8 mL, and centrifugation-based systems (e.g., Harvest®) were predominantly used. In the corticosteroid group, injections were uniformly combined with local anesthetics, primarily methylprednisolone (40 mg) or betamethasone (2 mg). The most affected spinal levels were L4/5 and L5/S1. VAS scores were reported in 6 out of 7 studies, while ODI scores were documented in all studies. Adverse events were described in two studies.

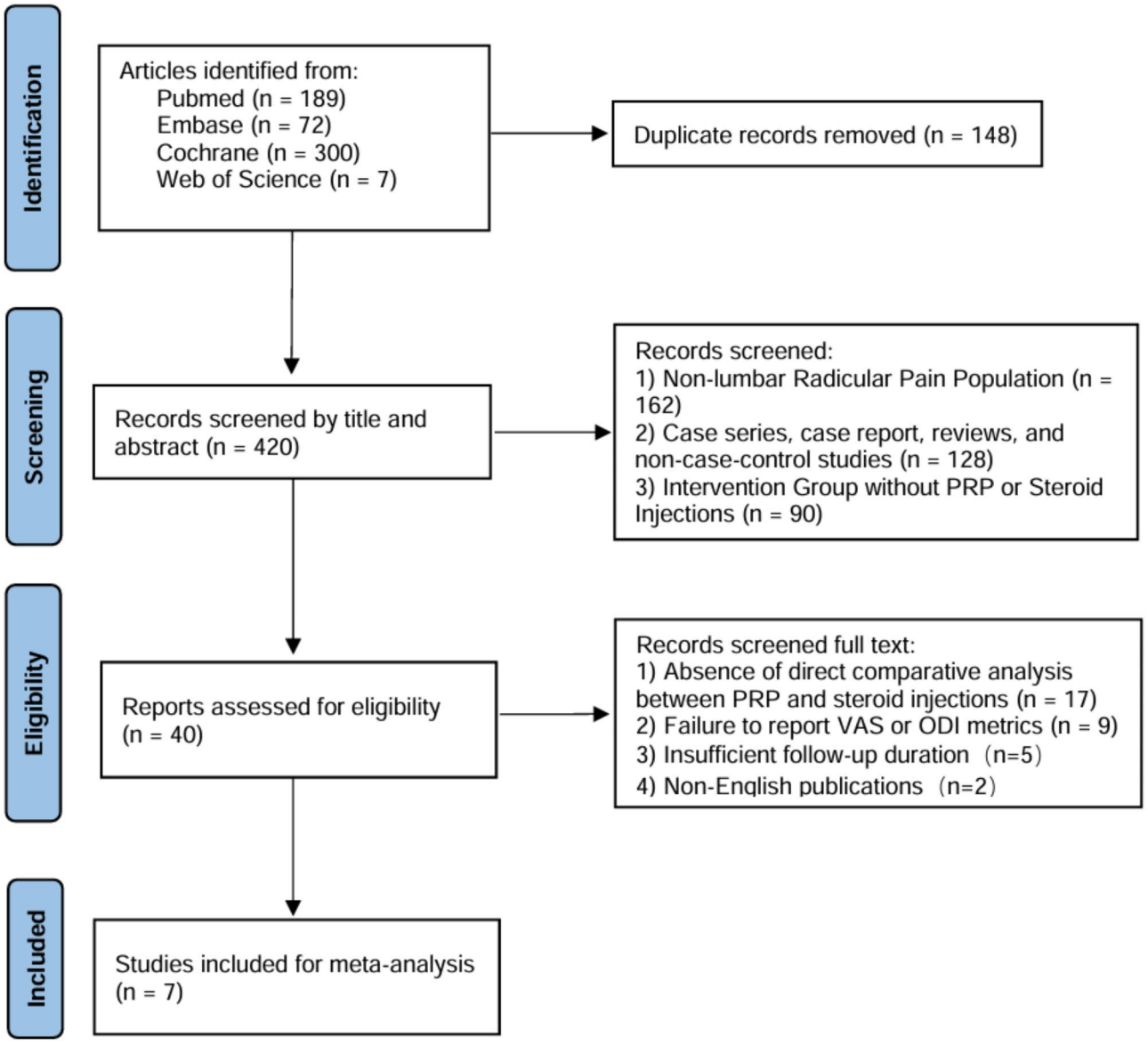

Fig. 1 Detailed flowchart of the study selection process

Key characteristics of the included studies are summarized in Table 1.

Quality assessment results

The risk of bias assessments for the included RCTs are depicted in Fig. 2 A and B. Among the RCTs: Four studies described specific methods for random sequence generation (e.g., computer-generated randomization), and three reported allocation concealment using opaque sealed envelopes. Four studies implemented double blinding (blinding of participants/personnel and outcome assessors). Five studies demonstrated balanced baseline characteristics and a dropout rate < 10%. Two studies explicitly referenced pre-registered protocols. Two studies explicitly referenced pre-registered protocols. For non-RCTs (Fig. 3): The retrospective cohort study was rated as having a high risk of selection bias, while other domains (e.g., confounding, outcome measurement) were deemed low risk. Overall, most included studies demonstrated a low risk of bias, with some domains categorized as "unclear risk" due to incomplete reporting.

Meta-Analysis results

Pain intensity (VAS Scores)

Six studies ($n = 356$) compared improvements in VAS scores between PRP and corticosteroid injections. No statistically significant differences were observed between the groups across short- to long-term follow-ups: SMD = 0.438 at 4 weeks (95% CI: -0.22 to 1.08, $p = 0.20$, I^2 = 86%); SMD = -0.69 at 3 months (95% CI: -1.67 to 0.28, $p = 0.16$, I^2 = 92%); SMD = -0.25 at 6 months (95% CI: -1.26 to 0.76, $p = 0.62$, I^2 = 93%) (Fig. 4A–C). Pooled analysis revealed that PRP did not demonstrate significant superiority over corticosteroids in reducing pain intensity from short- to long-term follow-up.

Functional disability (ODI Scores)

Pooled analysis of ODI scores from six studies ($n = 356$) revealed that the corticosteroid group demonstrated significant superiority over the PRP group at 4 weeks (SMD = 0.48, 95% CI: 0.20 to 0.75, $p = 0.0008$, I^2 = 15%). However, no significant differences were observed at 3 months (SMD = 0.08, 95% CI: -0.28 to 0.44, $p = 0.67$, I^2 = 49%) or 6 months (SMD = -0.25, 95% CI: -0.54 to 0.04, $p = 0.09$, I^2 = 31%) (Fig. 5A–C). These findings indicated that corticosteroids provided significant short-term improvement in functional disability compared to PRP in patients with lumbar radicular pain during the early follow-up period (4 weeks).

Adverse events

Four studies ($n = 230$) reported post-treatment complications: Incidence rate of 1.7% in PRP group (2 of 115 cases), including 1 case of transient post-injection pain and 1 case of self-limited muscle weakness. Incidence rate of 2.6% in corticosteroid group (3 of 115 cases), comprising 2 cases of persistent pain and 1 case of self-limited muscle weakness. Post-injection pain was likely attributable to the injection procedure itself, while muscle weakness resolved spontaneously within the follow-up period. No other serious adverse events (e.g., neurological injury, infection) were reported. Three studies did not document complications.

Discussion

This systematic review and meta-analysis is the first to comprehensively compare the dynamic efficacy of PRP versus corticosteroid injections in the treatment of lumbar radicular pain at 4 weeks, 3 months, and 6 months, and to summarize the associated risks of complications. The aggregated analysis results suggest that corticosteroids may significantly improve patient function (ODI) in the short term (4 weeks), but there is no significant difference in pain relief (VAS) scores between the two groups. In the medium- and long-term follow-up (3 and 6 months), the efficacy of both treatments tends to converge, and although there is no statistical difference, PRP shows a trend of advantage at 6 months. As for adverse events, the incidence of complications is similar between the two groups, but the adverse reactions associated with PRP are more self-limiting.

A previous study showed that PRP injection significantly improved VAS scores of patients at 6 weeks, 12 weeks, and 24 weeks, demonstrating a clinical efficacy superior to corticosteroid injections [35]. In a follow-up study by Akeda et al. [32] lasting 60 weeks, PRP was found to significantly improve disability scores and early walking ability compared to corticosteroid injections, but there were no significant improvements in radiological indicators and ratings. However, Bise et al. [30] found that both the PRP and corticosteroid groups improved preoperative pain and ODI scores in patients with lumbar radicular pain, but there were no significant differences in pain and ODI scores between the two groups at the follow-up endpoint (6 weeks). In an RCT with more than one year of follow-up, no significant differences were observed between the PRP and corticosteroid groups in pain, disability, and functional scores [31]. These findings suggest that PRP may be a safer alternative to corticosteroids, but the long-term safety and efficacy of PRP still require further validation through large-scale studies with extended follow-up.

Mechanistically, the significant advantage of corticosteroid injections in improving ODI at 4 weeks (SMD = 0.51, $p = 0.0008$) may be closely related to their rapid anti-inflammatory mechanisms. Glucocorticoids reduce the concentrations of inflammatory mediators such as prostaglandins and IL-6 around the nerve roots

Table 1 Main characteristics of all articles included in the meta-analysis

Author	Year	Country	Study design	Age (PRP vs. Corticosteroid, Years ± SD, range)	Number of female/male (PRP vs. Corticosteroid)	BMI (kg/m^2) (PRP vs. Corticosteroid)	affected levels(PRP vs. Corticosteroid)			PRP Preparation method	Volume of whole blood used	Injectate volume	Corticosteroid group	Adverse events
							L3/4	L4/5	L5/S1					
Bise et al.	2020	France	Non-RCT (Prospective study)	59 ± 15 vs. 50 ± 16	12/18 vs. 11/19	26 ± 4 vs. 25 ± 3	1 vs. 4	14 vs. 11	15 vs. 14	Harvest centrifuge	27 ml	2.5 ml	2.5 ml of an injectable particulate steroid solution	No complications
Xu et al.	2021	China	RCT	53.35 ± 11.76 vs. 54.94 ± 6.82	33/28 vs. 26/37	/	/	/	/	Harvest centrifuge	18 ml	3 ml	2 ml betamethasone + 0.5 ml 0.9% sterile saline + 0.5 ml 2% lidocaine	No complications
Akeda et al.	2022	Japan	RCT	35.1 ± 8.7 vs. 27.9 ± 5.2	3/6 vs. 2/5	/	1 vs. 3	5 vs. 6	5 vs. 1	Harvest centrifuge	400 ml	2 ml	betamethasone sodium phosphate(2 mg in 2.0 ml of saline)	1 post-injection pain and 1 mild muscle weakness in PRP group; 1 mild muscle weakness in corticosteroid group.
Demirci et al.	2022	Türkiye	Retrospective study	49.6 ± 13.0 vs. 46.8 ± 11.6	23/8 vs. 17/14	/	6 vs. 5	24 vs. 23	17 vs. 17	/	54 ml	8 ml	2 ml of bupivacaine and 1 ml of prilocaine diluted with serum physiological and 40 mg methylprednisolone	No report
Saraf et al.	2023	India	RCT	42.03 ± 11.31 vs. 45.83 ± 12.35	14/15 vs. 15/16	23.21 ± 4.68 vs. 22.05 ± 3.03	2 vs. 1	20 vs. 24	7 vs. 6	York centrifuge machine	34–45 ml	3 ml	2 ml of methylprednisolone acetate (40 mg/ml) with 1 ml 1% lignocaine	No report

Table 1 (continued)

Author	Year	Country	Study design	Age (PRP vs. Corticosteroid, Years ± SD, range)	Number of female/male (PRP vs. Corticosteroid)	BMI (kg/m^2) (PRP vs. Corticosteroid)	affected levels(PRP vs. Corticosteroid)			PRP Preparation method	Volume of whole blood used	Injectate volume	Corticosteroid group	Adverse events
							L3/4	L4/5	L5/S1					
Wongjarupong et al.	2023	Thailand	RCT	39.73 ± 7.04 vs. 39.13 ± 7.21	6/9 vs. 7/8	27.89 ± 4.88 vs. 25.55 ± 4.15	/	8 vs. 7	7 vs. 8	Harvest centrifuge	26 ml	2 ml	2 ml of 1% lidocaine with 40 mg triamcinolone	2 persistent pain in corticosteroid group.
Jayasoorya et al.	2024	India	RCT	/	32/32	/	/	/	/	REMI R-8 C centrifuge	20 ml	3 ml	1.5 ml of methylprednisolone, 1.5 ml of 2% lidocaine, and 0.5 ml of saline	No report

by inhibiting phospholipase A2 and COX-2 expression, thereby alleviating edema and improving nerve function conduction [37]. This is consistent with the conclusions reported by Jayasoorya et al. [36], who found that corticosteroid injections significantly reduced patients' 1-hour VAS scores compared to PRP. Interestingly, in longer-term follow-ups (3 months), PRP showed a superior effect in improving VAS pain scores compared to corticosteroids. In this study, corticosteroid injections did not significantly improve ODI scores at 3 months and 6 months, likely due to the diminishing efficacy over time as a result of endogenous cortisol feedback and receptor downregulation [38]. In contrast, although PRP did not show an immediate advantage in improving VAS/ODI scores, it demonstrated a trend toward improvement in ODI scores at 6 months (SMD=-0.54, $p = 0.09$), suggesting its potential neurorepair effects. Zhu et al. [39] constructed a co-culture system of PRP and Schwann cells (SCs) from the dorsal root ganglion and found that PRP significantly promoted the early secretion, proliferation, migration of SCs, and axonal regeneration. Mechanistically, PRP can activate the PI3K/Akt pathway through the release of IGF-1 to inhibit endothelial cell apoptosis and microvascular damage induced by spinal cord injury [40]. However, the optimal timing for promoting nerve regeneration may vary due to the sustained release of growth factors from PRP. For example, Saraf et al. [34] found that both PRP and corticosteroids improved clinical outcome scores in patients with lumbar radicular pain at 3 months, but only PRP showed sustained improvement in clinical scores at long-term follow-up (6 months). In an animal model, the PRP group demonstrated the best repair effect on a 12-mm defect in the rabbit tibial nerve at 12 weeks post-surgery [39].

It is worth noting that there is heterogeneity in PRP characteristics among the seven included studies, specifically in three aspects: different preparation methods, the volume of whole blood used, and the injection volume (Table 1). Therefore, the results should be interpreted with caution. Regarding PRP injection volume, six studies reported an injection volume of 2–3 mL, while only one study used an injection volume of 8 mL [33]. However, due to the limited inclusion of studies with high-concentration PRP, it is difficult to explore the clinical efficacy of high- versus low-concentration PRP in patients with lumbar radicular pain through subgroup analysis. One study reported that after an epidural injection of PRP at twice the concentration, patients experienced significant improvements in pain, disability, and quality of life, which persisted for up to 12 months [41]. However, in our included studies, the injection volume ranged only from 2 to 8 mL and did not show improvements in pain and functional scores compared to steroids. This may be attributed to the small injection volume of PRP, leading to suboptimal efficacy. Future clinical trials should standardize PRP preparation and intervention protocols while extending follow-up periods to evaluate the medium- and long-term efficacy and safety of different PRP concentrations and volumes in patients with lumbar radicular pain. Regarding PRP concentration, most

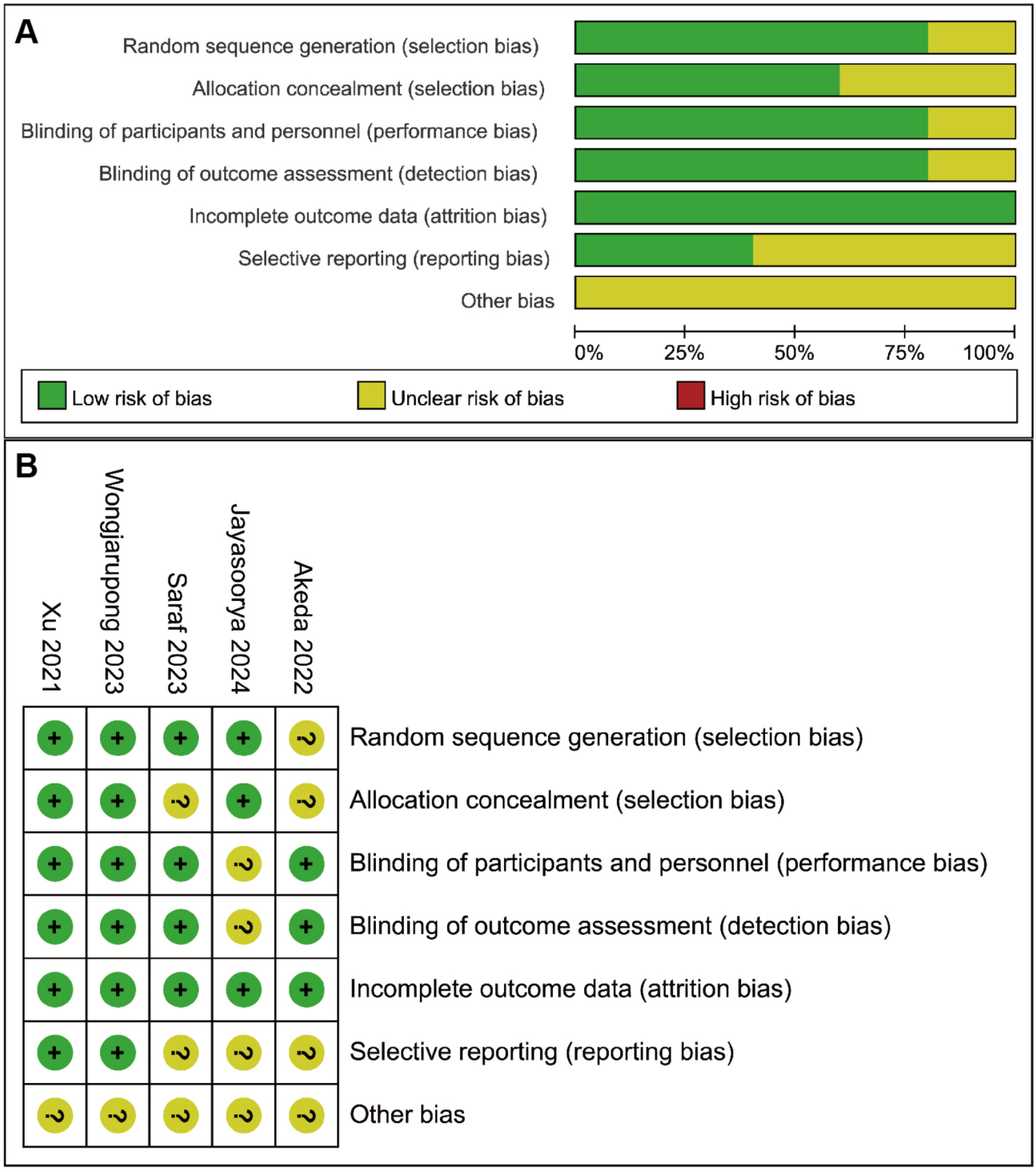

Fig. 2 Risk of bias of the included randomized controlled trials (RCTs). (**A**) Risk of bias graph; (**B**) Risk of bias summary

previous studies have shown that PRP injections with a concentration increase of less than five times are effective in treating chronic lumbar radicular pain [42, 43]. A recent clinical study by Playfair et al. found that a higher concentration of PRP (>10×) significantly improved pain and patient satisfaction at an average follow-up of 18 months [44]. Interestingly, some studies have shown a positive linear relationship between platelet content in PRP preparations and the concentration of TGF-β or PDGF, which is correlated with clinical outcomes in patients [45]. However, the long-term efficacy and

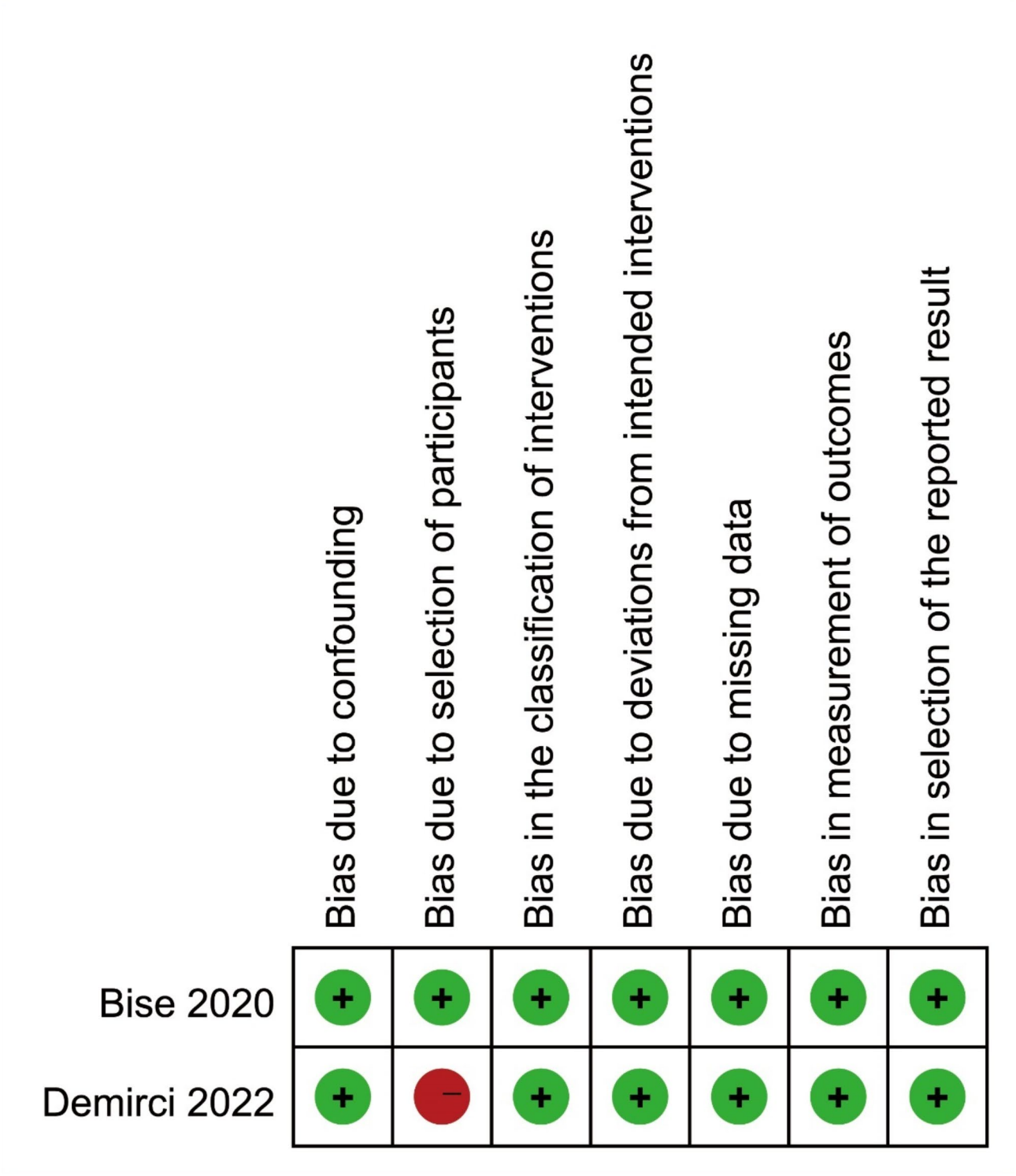

Fig. 3 Risk of bias of the included non-randomized controlled trials (RCTs)

safety of high-concentration PRP still require further investigation.

Furthermore, this study focuses on the early and mid-term efficacy (≤6 months) of PRP and steroids in treating lumbar radicular pain. However, long-term efficacy and safety assessments (>12 months) are crucial. Centeno et al. [46] reported the long-term effects of PRP in treating lumbar radicular pain, showing significant pain relief over a two-year follow-up period without serious adverse events. Another study also demonstrated that

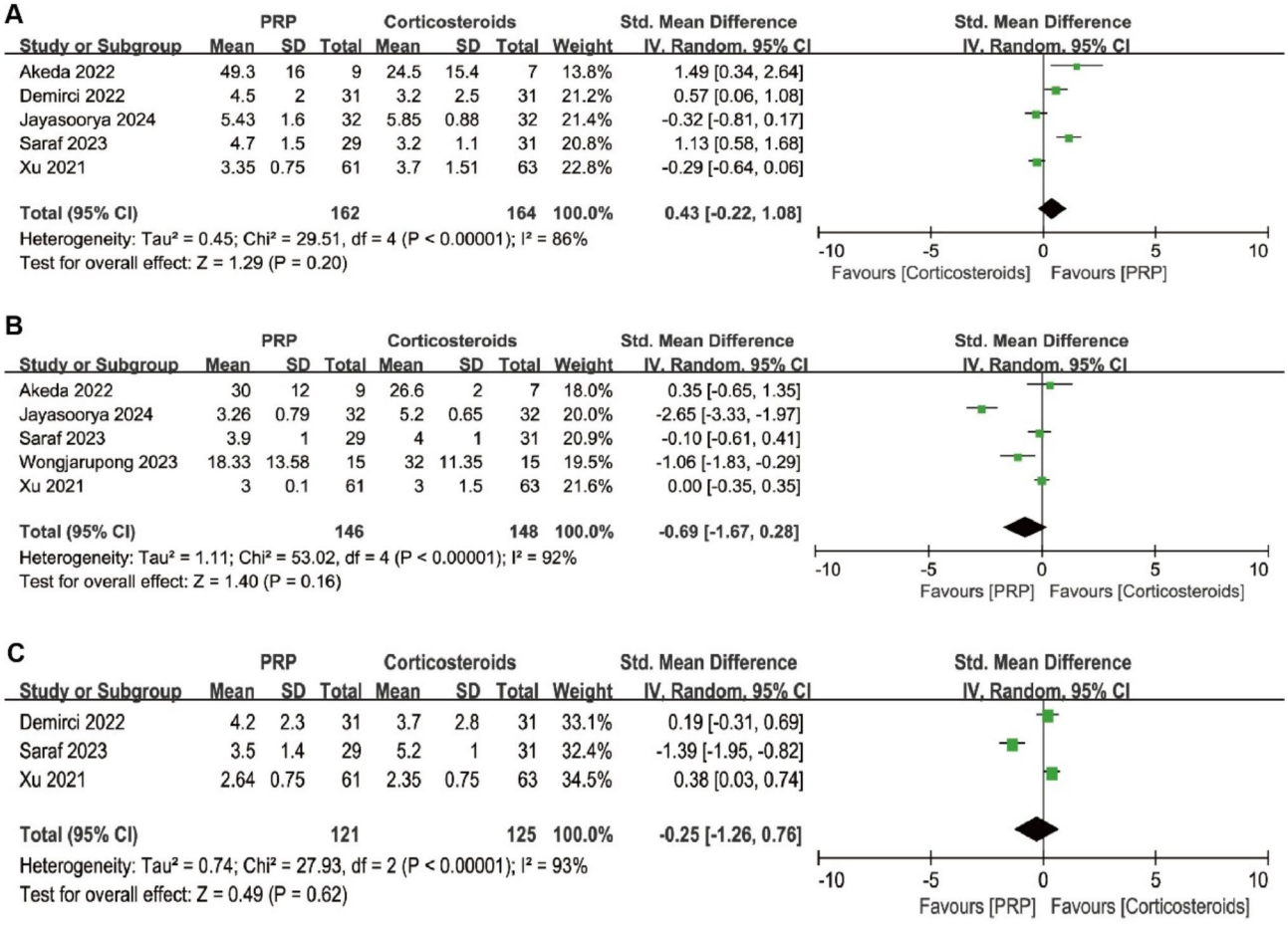

Fig. 4 Forest plot displaying the results of the meta-analysis for VAS scores at different follow-up times. (**A**) VAS scores at 3 days; (**B**) VAS scores at 3 months; (**C**) VAS scores at 6 months

PRP treatment effectively alleviated pain and improved function over a 60-week follow-up period [32]. However, due to the lack of standardized follow-up time points and the small sample size, this study is unable to compare the long-term efficacy and safety (> 12 months) of PRP and steroids in treating lumbar radicular pain through meta-analysis. Previous studies have shown that steroid treatment for lumbar radicular pain carries a risk of serious adverse events [47]. A comprehensive systematic review indicated that the incidence of adverse events related to PRP use in the lumbar spine is relatively low, with strong supporting data [48]. Therefore, PRP may serve as a potential alternative to steroid treatment for lumbar radicular pain, particularly in reducing side effects. In the future, multicenter and large-scale clinical trials are essential to strengthen the evidence for the efficacy and safety of PRP in treating lumbar radicular pain.

This study has several limitations. First, only five RCTs were included, and some studies did not implement blinding, which may affect the robustness of the analysis results. Second, the preparation parameters of PRP (such as centrifugation force and activators) lack standardization, leading to significant heterogeneity between the studies. Additionally, the longest follow-up period was 12 months, which does not allow for the assessment of the long-term (> 1 year) efficacy of PRP in treating lumbar radicular pain. Future studies should extend follow-up periods and increase sample sizes to further validate the sustained efficacy and safety of PRP. Finally, incomplete reporting of complications in some studies may result in an underestimation of risks.

Conclusions

Compared to corticosteroid injections, PRP did not show superior improvements in VAS and ODI scores for lumbar radicular pain. In contrast, corticosteroids demonstrated significant improvement in patient ODI scores in the short term (4 weeks). However, due to the low quality of the included studies and the heterogeneity in PRP preparation methods, there is a need for higher-quality RCTs with standardized PRP preparation protocols and longer follow-up periods to investigate the efficacy and safety of PRP versus corticosteroid injections in the treatment of lumbar radicular pain.

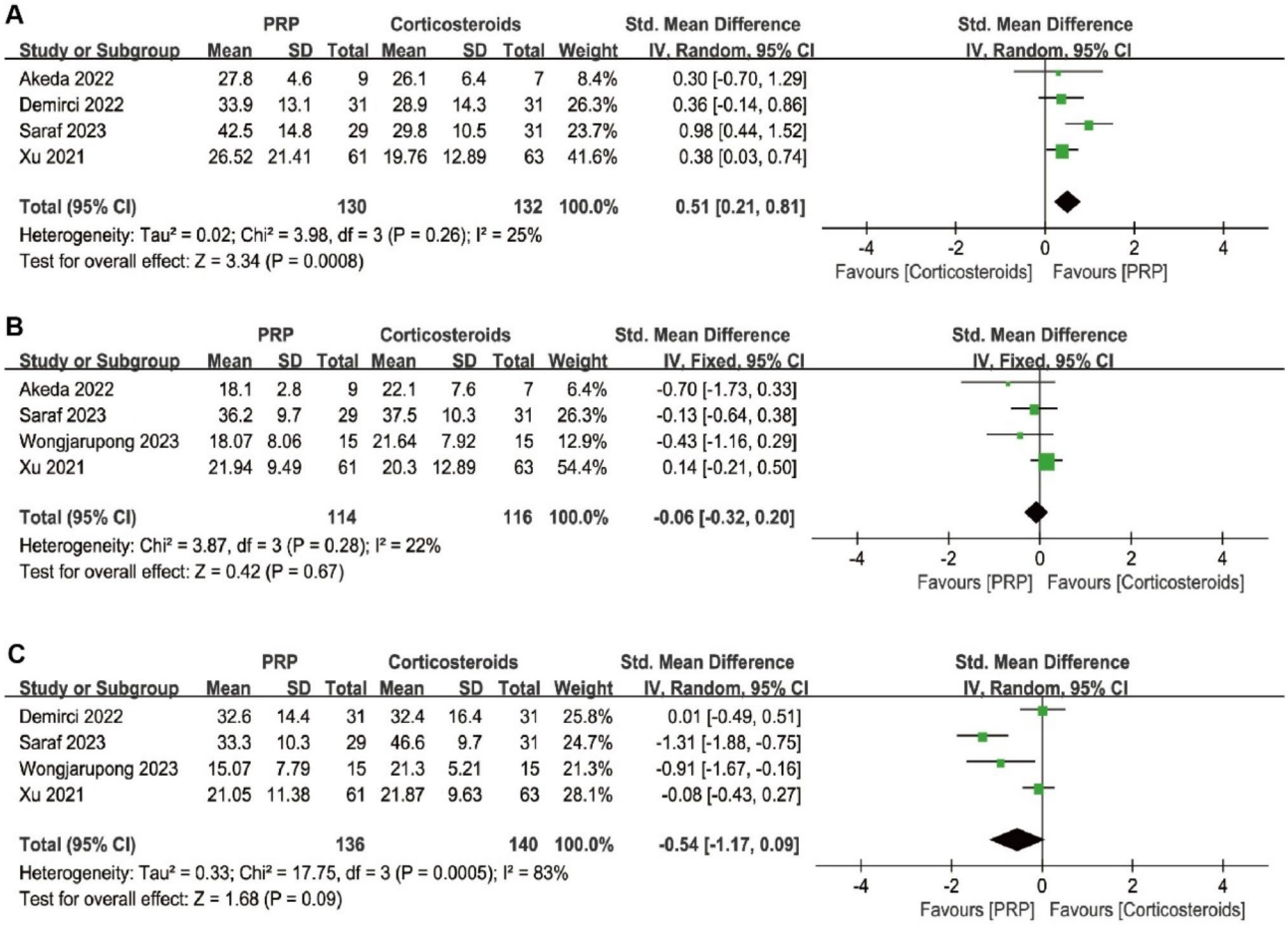

Fig. 5 Forest plot displaying the results of the meta-analysis for ODI scores at different follow-up times. (**A**) ODI scores at 4 weeks; (**B**) ODI scores at 3 months; (**C**) ODI scores at 6 months

Abbreviations

CI	Confidence Interval
CT	Computed Tomography
ESIs	Epidural Corticosteroid Injections
IL-1Ra	Interleukin-1 Receptor Antagonist
MRI	Magnetic Resonance Imaging
NSAIDs	Non-Steroidal Anti-Inflammatory Drugs
ODI	Oswestry Disability Index
PDGF	Platelet-Derived Growth Factor
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PRP	Platelet-Rich Plasma
RCT	Randomized Controlled Trial
ROBINS-I	Risk Of Bias In Non-randomized Studies of Interventions
SMD	Standardized Mean Difference
TGF-β1	Transforming Growth Factor-Beta 1
VAS	Visual Analog Scale

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Not applicable.

Author contributions
Xinan Wang and Ying Zhang conceived the study and wrote the manuscript. Xinan Wang carried out the data collection and data analysis. Ying Zhang contributed to the data curation, methodology, and validation. All authors reviewed the results and approved the final version of the manuscript.

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Data availability
All data relevant to the study are included in the article.

Declarations

Ethics approval and consent to participate
Not applicable.

Competing interests
The authors declare no competing interests.

Supplementary information
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