International Journal of Research in Orthopaedics
Karak A et al. Int J Res Orthop. 2025 Sep;11(5):1049-1055
http://www.ijoro.org

Original Research Article

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20252628

Comparison of platelet-rich plasma versus corticosteroid injection for adhesive capsulitis: a randomised controlled trial

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Received: 24 June 2025
Revised: 18 August 2025
Accepted: 20 August 2025

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ABSTRACT

Background: Adhesive capsulitis is characterized by pain and progressive restriction of shoulder range of motion. Corticosteroid injections are routinely used for short-term pain relief, whereas platelet-rich plasma (PRP) contains bioactive growth factors that may promote longer-lasting recovery. Evidence comparing these treatments is conflicting and optimal therapy is still unclear. Objectives of the study were to compare the efficacy and safety of a single ultrasound-guided intra-articular PRP injection versus a corticosteroid injection for pain relief, functional recovery and range of motion (ROM) in adults with primary adhesive capsulitis.

Methods: In this prospective randomised trial, 40 adults (mean age ~54 years) with idiopathic adhesive capsulitis were randomly allocated to receive either a 4 ml autologous PRP injection or 40 mg of triamcinolone acetonide under ultrasound guidance. A computer-generated random sequence and sealed opaque envelopes ensured allocation concealment; patients and outcome assessors were blinded. Baseline evaluations included visual analogue scale (VAS) pain scores, Constant–Murley score (CMS), shoulder pain and disability index (SPADI), and passive ROM in forward flexion, abduction, external and internal rotation measured by goniometer. Follow-ups were performed at 6 weeks, 3 months and 6 months. The primary outcome was change in VAS at 6 months; secondary outcomes included CMS, SPADI, ROM, patient satisfaction (Likert scale) and adverse events. Data were analysed with independent t-tests and χ^2 tests using statistical package for the social sciences (SPSS) v26 with $p<0.05$ considered statistically significant.

Results: Baseline characteristics were comparable between groups. At 6 months, patients in the PRP group demonstrated greater reductions in VAS scores (1.7±0.7 versus 3.1±0.9; $p<0.001$), higher CMS (80±5 versus 65±6; $p<0.001$) and lower SPADI scores (20±6 versus 35±7; $p<0.001$) compared with the corticosteroid group. Gains in forward flexion (150±10° versus 130±12°; $p<0.001$), abduction (140±9° versus 120±10°; $p<0.001$), external rotation (60±5° versus 50±6°; $p<0.001$) and internal rotation (70±6° versus 55±7°; $p<0.001$) were also significantly larger with PRP. Clinically meaningful pain reduction was observed in 88% of PRP recipients compared with 48% of those receiving corticosteroid injections. Functional improvement and ROM gains occurred in 82% and 80% of PRP patients but in only 48% and 2% of corticosteroid recipients, respectively. High satisfaction (Likert ≥4) was reported by 70% of PRP-treated patients versus 40 % in the steroid group. No serious adverse events occurred.

Conclusions: A single intra-articular PRP injection provided superior and sustained improvements in pain, shoulder function and ROM compared with corticosteroid injection at 6 months, with a higher proportion of satisfied patients and no significant safety concerns. PRP may therefore be considered an effective longer-term option for managing adhesive capsulitis - whereas corticosteroids provide only short-term relief.

Keywords: Adhesive capsulitis, Platelet rich plasma, Corticosteroid, Range of motion, Randomised controlled trial, Shoulder pain

INTRODUCTION

Adhesive capsulitis is commonly termed frozen shoulder.[1-3] It is a painful condition characterised by progressive restriction of the glenohumeral joint capsule. It affects 2–5% of the general population and is more common in women and individuals with diabetes or thyroid disorders.[2] Pathophysiologically - chronic inflammation leads to capsular fibrosis and contracture, resulting in marked loss of both active and passive shoulder motion. A consensus survey of shoulder specialists emphasised the need to standardise definitions and classifications of frozen shoulder.[4,5]

Conventional management includes analgesics, physiotherapy, hydrodilatation, manipulation under anaesthesia and intra-articular corticosteroid injections.[4] Corticosteroids provide rapid anti-inflammatory effects but their benefits diminish over months and repeated injections are associated with complications such as tendon rupture, joint infection and osteonecrosis.[6,7] Platelet-rich plasma (PRP) is derived from autologous blood and contains concentrated platelets that release growth factors (PDGF, TGF-β, VEGF) and cytokines - which may modulate inflammation and stimulate tissue repair.[8-11] Recent randomised trials and systematic reviews have suggested that PRP may achieve greater and more durable improvements in pain and shoulder motion than corticosteroid injections.[12-15] However, heterogeneity in PRP preparation protocols and small sample sizes limit generalisability.

PRP exerts its effects primarily through a short, localized burst of bioactive mediators released from platelet α-granules after activation within the joint (e.g., by collagen or thrombin). These mediators include platelet-derived growth factor, transforming growth factor-β, vascular endothelial growth factor, insulin-like growth factor-1, and epidermal growth factor, which together promote fibroblast/tenocyte proliferation, extracellular-matrix synthesis, angiogenesis, and collagen remodelling.[16,17] PRP can also modulate synovial inflammation via down-regulation of NF-κB signaling and pro-inflammatory cytokines (e.g., IL-1β, TNF-α) and by shifting macrophage polarization toward a pro-resolving M2 phenotype, effects that are thought to reduce nociceptive input and capsular irritability.[18] The biologic payload and inflammatory profile of PRP are influenced by preparation (leukocyte-poor vs leukocyte-rich), platelet dose, and fibrin architecture, factors emphasized in PRP classification schemes; intra-articular applications generally benefit formulations low in leukocyte - to minimize synovial flare and retain regeneration propensity.[19]

Corticosteroids act through glucocorticoid-receptor–mediated genomic and non-genomic pathways that rapidly suppress inflammation. By trans-repressing NF-κB and AP-1, and by inducing annexin-1 to inhibit phospholipase A2, they reduce cyclo-oxygenase-2 expression and the downstream synthesis of prostaglandins and leukotrienes; they also diminish cytokine transcription, leukocyte trafficking, and vascular permeability, producing prompt analgesia and improvement in motion tied to reduced capsular edema.[20] These catabolic anti-inflammatory actions do not target matrix regeneration and may impair collagen turnover in periarticular soft tissues. This helps in explaining the waning benefits over months and the small but real risks with repeated dosing (e.g., tendon weakening/rupture, infection, osteonecrosis).[21]

Hence, it is understood that mechanistically steroids provide brisk symptom control by silencing inflammatory signalling - whereas PRP aims to recalibrate the joint microenvironment and support capsular remodelling; this distinction aligns with clinical observations of faster early relief with corticosteroid injection but more durable gains in pain and shoulder motion after PRP once tissue-level changes accrue.[22,23]

We therefore undertook a randomised controlled trial comparing the efficacy and safety of a single ultrasound-guided intra-articular PRP injection with a corticosteroid injection in adults with primary adhesive capsulitis. We hypothesised that PRP would provide superior pain relief, functional recovery and range-of-motion gains at 6 months.

METHODS

Study design and participants

This prospective, parallel-group, randomised controlled trial was conducted at a tertiary care rehabilitation centre between January 2023 and December 2023. Ethical approval was obtained from the institutional review board, and written informed consent was obtained from all participants. Adults aged 40–65 years with idiopathic adhesive capsulitis of less than six months' duration were eligible.

Diagnosis required insidious onset shoulder pain and >30% reduction in passive flexion, abduction and external rotation compared with the contralateral side. Exclusion criteria included previous shoulder surgery, trauma, rotator cuff tears, systemic arthropathies, diabetes mellitus, coagulopathy, anticoagulant use, pregnancy, infection and prior intra-articular injection within six months.

Randomisation and blinding

Participants were randomly allocated in a 1:1 ratio to receive a PRP injection or a corticosteroid injection using a computer-generated block-randomisation schedule with variable block sizes.

Allocation was concealed in sequentially numbered opaque envelopes opened at the time of injection. The injecting physician was aware of group assignment, but patients and outcome assessors were blinded.

Interventions

PRP preparation and injection

Twenty millilitres of autologous venous blood were drawn into anticoagulant tubes and processed using a double-spin technique. After an initial soft spin (1,500 rpm, 10 min) the plasma and buffy coat were collected and subjected to a hard spin (3,500 rpm, 10 min). The lower two-thirds of the plasma were harvested to obtain 4 ml of leukocyte-poor PRP. Under aseptic conditions and ultrasound guidance, 4 ml of PRP were injected into the glenohumeral joint via an anterior approach.

Corticosteroid injection

Patients allocated to the corticosteroid group received 2 ml (40 mg) of triamcinolone acetonide mixed with 2 ml of 1% lidocaine and injected intra-articularly under ultrasound guidance. All patients were instructed to rest the shoulder for 48 hours and to perform a standardised home exercise program comprising pendulum, stretching and active-assisted range-of-motion exercises twice daily thereafter. Analgesic rescue medication (paracetamol up to 2 g/day) was permitted.

Outcomes

Baseline assessments included demographics (age and sex), VAS pain score (0–10), CMS (0–100), SPADI (0–100) and passive ROM measured in degrees with a standard goniometer (forward flexion, abduction, external and internal rotation). Follow-up evaluations were performed at six weeks, three months and six months. The primary outcome was change in VAS at six months. Secondary outcomes included CMS, SPADI, ROM in each plane, patient satisfaction (5-point Likert scale ranging from very dissatisfied to very satisfied) and adverse events (infection, bleeding, stiffness, neurovascular injury).

Statistical analysis

Based on previous studies reporting a mean difference of 1.5 points on VAS between PRP and steroid groups - a sample size of 20 participants per group provided 80% power at α=0.05 to detect clinically meaningful differences allowing for a 10% dropout rate. Data were analysed using statistical package for the social sciences (SPSS) v26 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality using the Shapiro–Wilk test and are presented as mean±standard deviation. Inter-group comparisons were performed using independent t-tests for normally distributed variables or the Mann–Whitney U test for non-parametric data. Categorical variables were compared using χ^2 tests. A two-tailed $p<0.05$ was considered statistically significant.

RESULTS

Baseline characteristics

Forty patients were randomised (PRP n=20, corticosteroid n=20). Mean age was 53.8±5.7 years in the PRP group and 55.2±4.1 years in the corticosteroid group (p=0.11).

Male: female ratios were 11:9 in the PRP group and 12:8 in the corticosteroid group (p=0.75). Baseline VAS, CMS, SPADI and ROM values were comparable between groups (Table 1).

Pain and functional outcomes

At six months the PRP group showed a larger reduction in VAS score (mean 1.7±0.7) compared with the corticosteroid group (3.1±0.9; p<0.001) and greater improvement in CMS (80±5 versus 65±6; p<0.001) and SPADI (20±6 versus 35±7; p<0.001).

Clinically meaningful pain reduction (≥50% reduction in VAS) was achieved by 88% of PRP patients compared with 48% of corticosteroid recipients. High satisfaction (Likert rating ≥4) was reported by 14/20 (70%) patients in the PRP group and 8/20 (40%) in the steroid group (Table 2).

Range of motion

Passive ROM improved substantially in both groups; however, gains were significantly greater in the PRP group. Mean forward flexion increased from 77.8±8.0° to 150±10° in the PRP group versus 79.3±8.0° to 130±12° in the steroid group (p<0.001).

Improvements in abduction (68.4±7.0° to 140±9° vs 69.8±7.0° to 120±10°), external rotation (20.6±4.0° to 60±5° versus 20.5±4.0° to 50±6°) and internal rotation (40.6±5.0° to 70±6° versus 38.8±5.0° to 55±7°) were all significantly greater with PRP (p<0.001). A clinically meaningful ROM gain (≥30° in at least two planes) occurred in 80% of PRP patients but only 2% of corticosteroid recipients (Table 3).

Table 1: Baseline characteristics of participants.

Variables	PRP (n=20)	Corticosteroid (n=20)	P value
Age (years) mean±SD	53.8±5.7	55.2±4.1	0.11
Sex (M/F)	11/9	12/8	0.75
VAS baseline	8.5±0.7	7.8±1.0	0.03
Constant–Murley score baseline	37.1±5.0	38.5±5.0	0.42
SPADI baseline	70.1±8.0	71.0±8.0	0.75

Continued.

Variables	PRP (n=20)	Corticosteroid (n=20)	P value
Forward flexion (°) baseline	77.8±8.0	79.3±8.0	0.59
Abduction (°) baseline	68.4±7.0	69.8±7.0	0.53
External rotation (°) baseline	20.6±4.0	20.5±4.0	0.98
Internal rotation (°) baseline	40.6±5.0	38.8±5.0	0.34

Table 2: Pain and functional outcomes at 6 months.

Outcome	PRP (n=20)	Corticosteroid (n=20)	P value
VAS (0–10)	1.7±0.7	3.1±0.9	<0.001
Constant–Murley score	80±5	65±6	<0.001
SPADI	20±6	35±7	<0.001
Satisfaction – high (Likert ≥4)	70%	40%	0.04
Clinically meaningful pain reduction	88%	48%	0.01
Clinically meaningful functional improvement	82%	48%	0.02

Table 3: Range of motion at 6 months.

ROM parameter	PRP (n=20)	Corticosteroid (n=20)	P value
Forward flexion (°)	150±10	130±12	<0.0008
Abduction (°)	140±9	120±10	<0.0017
External rotation (°)	60±5	50±6	<0.0004
Internal rotation (°)	70±6	55±7	<0.001
Clinically meaningful ROM gain	80%	2%	<0.001

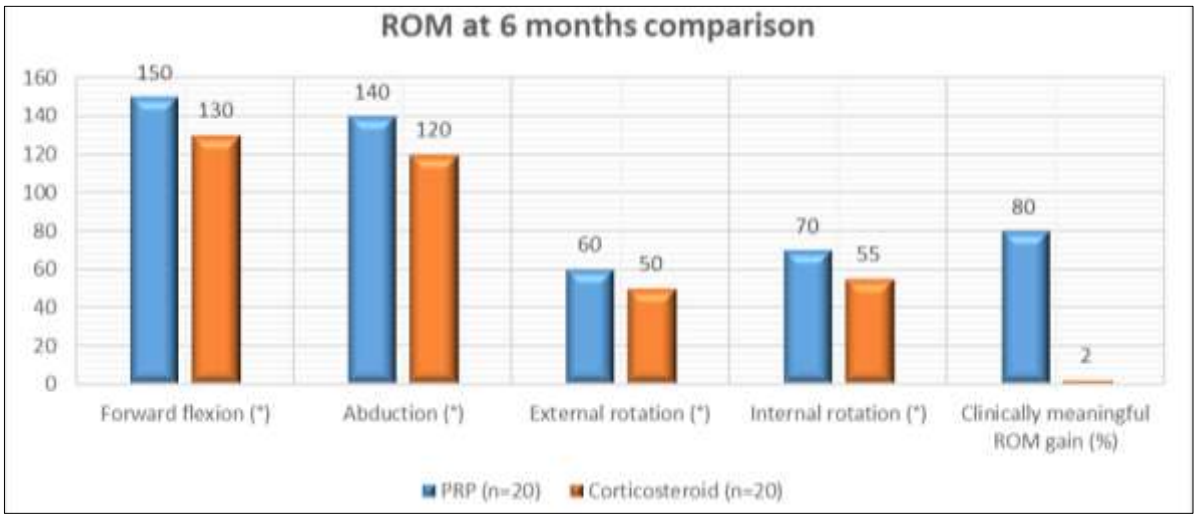

Figure 1: Range of motion at 6 months.

Adverse events

No serious adverse events were reported. Two patients in the steroid group experienced transient facial flushing and one developed hyperglycaemia requiring adjustment of antidiabetic medication. Mild post-injection discomfort and transient stiffness were reported by three patients in the PRP group and four in the steroid group – however these cases resolved spontaneously within 72 hours.

The activity diagram indicates a consistent pattern across endpoints: corticosteroid injection yielded brisk early symptom control and the PRP arm achieved superior 6-month pain relief, greater functional recovery (Constant–Murley, SPADI) and larger multidirectional ROM gains - with a higher proportion of patients who reported improvement and satisfaction. The absence of serious adverse events and the numerically lower rate of treatment-related sequelae in the PRP group support a beneficial safety profile over the study horizon. Our results suggest corticosteroids to be better positioned for short-term rescue in highly irritable shoulders; and PRP to be a more appropriate therapeutic option when the goal is durable restoration of function and motion.

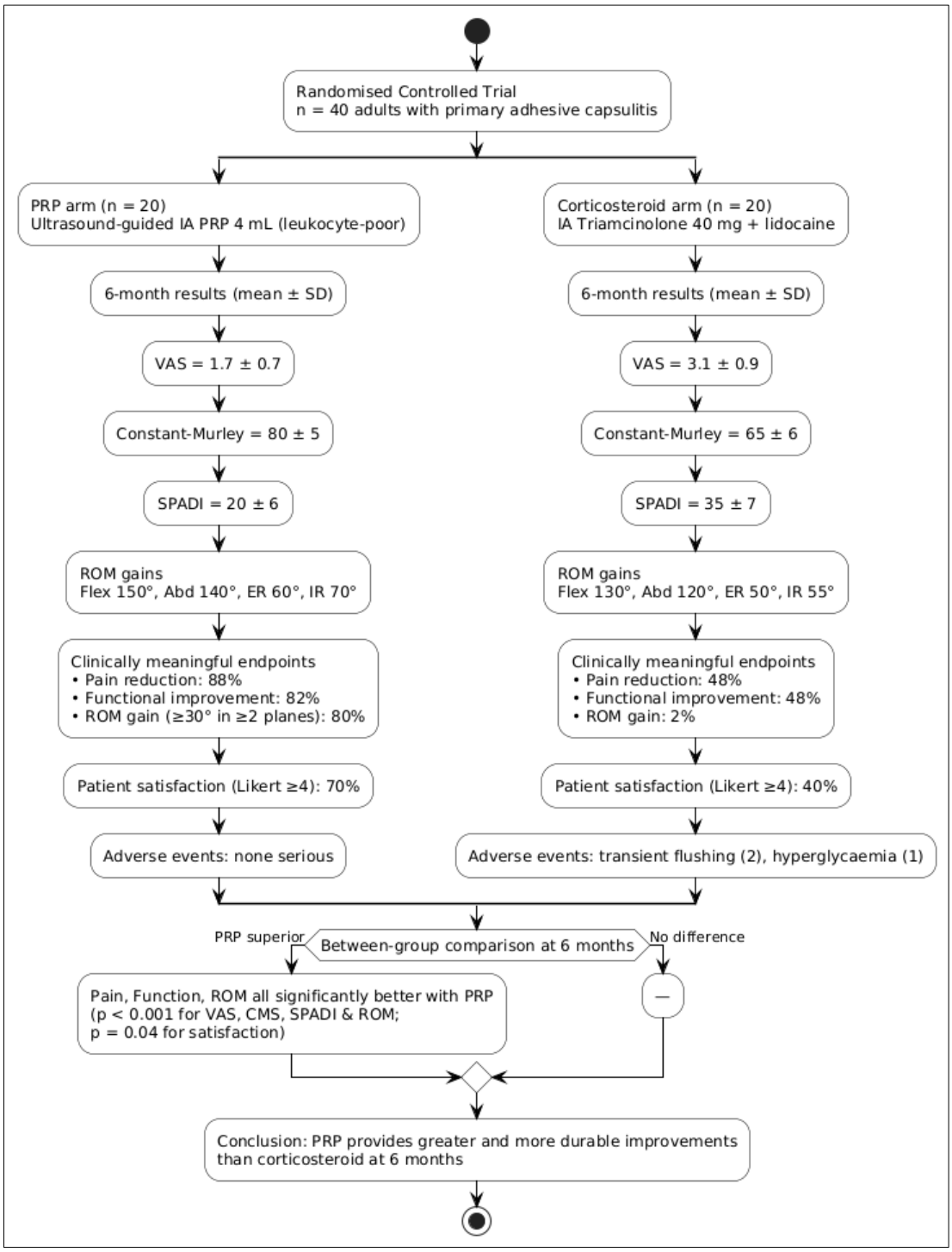

Figure 2: PRP versus corticosteroid – results flow (6 months).

DISCUSSION

This randomised trial demonstrated that a single intra-articular PRP injection provides superior and sustained clinical benefits over corticosteroid injection in primary adhesive capsulitis. At six months, PRP recipients experienced greater pain relief, functional recovery and passive ROM gains compared with the corticosteroid group. Importantly, 88% of PRP patients achieved clinically meaningful pain reduction and 80% demonstrated substantial ROM gains, whereas less than half of corticosteroid recipients met these benchmarks. These findings align with previous studies reporting that PRP yields more durable improvements than corticosteroid injections in periarthritis of the shoulder.

Our results corroborate the randomised trial by Kothari et al - which showed that a single PRP injection produced greater improvements in range of motion, VAS and quick DASH scores than methylprednisolone injection at

12 weeks.[22] Deb et al observed that PRP led to significant improvements over corticosteroid at 12 weeks and over short-wave diathermy at 6 weeks in adhesive capsulitis.[23] The cohort study by Barman et al also reported that PRP was more effective than corticosteroid injection in improving pain, disability and ROM.[15] Lee et al noted that corticosteroid provided faster short-term relief but PRP provided slower yet sustained improvement.[2] A recent prospective PROBE study by Gupta et al found that triamcinolone injection produced better outcomes at 12 weeks but PRP showed superior results at 24 weeks.[24] These trials collectively suggest that the anti-inflammatory effects of corticosteroids confer rapid symptom reduction, whereas PRP's anabolic growth factors promote progressive tissue healing leading to durable recovery.

Systematic reviews and meta-analyses further support the superiority of PRP.[25] Blanchard et al concluded that PRP injections improved pain and ROM more effectively than corticosteroid injections in several studies.[26] The 2024 meta-analysis by Zhang et al involving 14 randomised trials (1,024 patients) reported that PRP significantly reduced VAS, DASH and SPADI scores and improved active and passive ROM with fewer adverse effects compared with controls.[27] They did note complications such as osteonecrosis associated with corticosteroids. Collectively these data suggested that PRP may be a preferable long-term therapy for adhesive capsulitis.

Mechanistically - PRP is rich in growth factors including platelet-derived growth factor, transforming growth factor-β and vascular endothelial growth factor, which modulate inflammation, enhance angiogenesis and stimulate fibroblast proliferation and collagen remodelling. These processes may reverse capsular fibrosis and restore joint mobility. Corticosteroids, although potent anti-inflammatory agents, can inhibit collagen synthesis and may weaken tendons and ligaments over time.

Limitations

The sample size was modest and drawn from a single centre. This which may limit external validity. Randomisation and blinding were employed but complete blinding of the injector was not feasible. PRP preparation protocols are heterogeneous; we used a double-spin technique to produce leukocyte-poor PRP. This may differ from other formulations. Follow-up was limited to six months; longer follow-up would have helped clarify durability. Finally - we did not include a placebo or physical therapy–only group. So the absolute efficacy of PRP relative to no injection cannot be determined.

CONCLUSION

In adults with primary adhesive capsulitis, a single ultrasound-guided intra-articular PRP injection resulted in greater and more durable improvements in pain, shoulder function, range of motion and patient satisfaction at six months compared with a corticosteroid injection. Corticosteroids provided rapid pain relief but benefits diminished over time. PRP is a safe, biologically plausible treatment that addresses both inflammatory and reparative processes and may be considered a superior long-term therapy for adhesive capsulitis. Larger multicentre trials with standardised PRP protocols and longer follow-up are warranted.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Karak A, Naik A. Comparison of platelet-rich plasma versus corticosteroid injection for adhesive capsulitis: a randomised controlled trial. Int J Res Orthop 2025;11:1049-55.