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Clinical Outcomes Following Three Intra-Articular Injections of Double-Spin Leukocyte-Reduced Platelet-Rich Plasma in Knee Osteoarthritis: A Retrospective Observational Study

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Abstract: ***Background**: Knee osteoarthritis (KOA) is a common degenerative joint disorder associated with pain, stiffness and functional limitation. Platelet-rich plasma (PRP) has emerged as a biological treatment option, although substantial heterogeneity exists in PRP preparation and treatment protocols. **Objective**: To evaluate clinical outcomes following three intra-articular administrations of double-spin, leukocyte-reduced PRP in patients with knee osteoarthritis. **Methods**: This retrospective observational cohort study was conducted in the Department of Orthopaedics, Jaipur National University, Jaipur, Rajasthan, from January 2026 to June 2026. A total of 210 documented patients were identified; 10 were excluded, leaving 200 eligible patients for analysis. The broader institutional service volume was approximately 210 PRP requisitions per month, totaling 1,260 requisitions over six months, and was distinct from the outcome-analysis cohort. Of the 200 eligible patients, 80 (40%) were male and 120 (60%) female. The predominant age group was 44–55 years. Unilateral involvement was present in 60 (30%) and bilateral involvement in 140 (70%). PRP was preferentially considered for Grade 1 and Grade 2 osteoarthritis; selected Grade 3 cases were treated with physiotherapy and conservative management. Approximately 8 mL of blood was collected into two ACD-containing tubes. Double-spin leukocyte-reduced PRP was prepared and approximately 4 mL was administered intra-articularly per knee at weeks 0, 4 and 8. Outcomes were assessed using VAS, WOMAC and Oxford Knee Score (OKS). **Results**: Follow-up data were available for 188 patients at 1 month, 178 at 3 months and 160 at 6 months. Mean VAS decreased from 8.00 ± 0.57 at baseline to 5.81 ± 0.64, 4.53 ± 0.62 and 3.25 ± 0.67 at 1, 3 and 6 months, respectively. Mean WOMAC decreased from 74.84 ± 3.02 to 61.25 ± 2.75, 52.72 ± 3.09 and 43.53 ± 2.99. Mean OKS increased from 19.28 ± 1.80 to 24.22 ± 1.26, 27.50 ± 1.05 and 30.34 ± 1.45. **Conclusion**: Three intra-articular administrations of double-spin, leukocyte-reduced PRP were associated with progressive improvement in pain and functional outcomes over six months.***

Keywords: Knee osteoarthritis; platelet-rich plasma; leukocyte-reduced PRP; double-spin PRP; VAS; WOMAC; Oxford Knee Score

1. Introduction

Knee osteoarthritis is a prevalent degenerative joint disease and an important cause of chronic pain, stiffness, reduced mobility and disability. It involves progressive alterations of articular cartilage, subchondral bone, synovium and surrounding tissues.

Conventional management includes exercise, physiotherapy, weight management, analgesics and intra-articular therapies. Interest has increased in biological treatments such as PRP, an autologous blood-derived preparation containing platelets and associated bioactive mediators.

Clinical outcomes following PRP vary between studies because PRP is not a uniform biological product. Differences in platelet concentration, leukocyte content, red-cell contamination, preparation technique, activation method, injection volume and number of injections may influence response. Recent randomized and systematic-review evidence supports continued evaluation of intra-articular PRP while emphasizing heterogeneity in formulations and protocols.

The present study evaluates a standardized institutional protocol consisting of three intra-articular administrations of double-spin, leukocyte-reduced PRP at four-week intervals and assesses clinical outcomes over six months.

2. Aim

To evaluate the clinical outcomes of three intra-articular administrations of double-spin, leukocyte-reduced platelet-rich plasma in patients with knee osteoarthritis.

3. Objectives

- To evaluate change in knee pain using the Visual Analogue Scale (VAS).
- To evaluate changes in WOMAC score.
- To evaluate changes in Oxford Knee Score.
- To assess the trajectory of clinical improvement at 1, 3 and 6 months.
- To describe the institutional PRP preparation and administration protocol.
- To describe the clinical service workload associated with PRP.

4. Materials and Methods

4.1 Study design

This was a retrospective observational cohort study based on institutional clinical records.

4.2 Setting and study period

The study was conducted in the Department of Orthopaedics, Jaipur National University Institute of Medical Sciences and Research Centre (JNUIMSRC), Jaipur, Rajasthan, India. The treatment and data-identification period was January 2026 to June 2026.

4.3 Participants

A total of 210 documented patients were identified for the outcome cohort. Ten patients were excluded, and 200 were eligible for final analysis.

4.4 Clinical service workload

The orthopaedic OPD received approximately 100–120 patients/day, and approximately 210 PRP requisitions were received per month. Over the six-month study period, the total service workload was therefore 1,260 PRP requisitions. These figures represent institutional service volume and are strictly distinct from the 200-patient outcome-analysis sample.

Service-volume basis	Value
Monthly PRP requisitions	210
Estimated daily PRP workload	~7/day
Six-month service volume	1,260

4.5 Eligibility

Patients with knee osteoarthritis who received the specified institutional PRP protocol and had clinical outcome documentation were considered eligible.

Patients with Grade 1–2 knee osteoarthritis were preferentially considered for PRP. Selected Grade 3 cases were managed with PRP along with physiotherapy and conservative treatment. Patients with Grade 4 osteoarthritis were excluded from the PRP treatment protocol.

Exclusion criteria:

- Patients with Grade 4 knee osteoarthritis.
- Patients with active local or systemic infection, because of the contraindication to intra-articular injection.

4.6 Demographic and clinical profile

Among the 200 eligible patients, 80 (40%) were male and 120 (60%) were female. The predominant age group was 44–55 years. Unilateral involvement was present in 60 (30%) patients and bilateral involvement in 140 (70%) patients. PRP was preferentially considered for Grade 1 and Grade 2 osteoarthritis. Selected Grade 3 cases were treated with PRP along with physiotherapy and conservative management.

4.7 PRP preparation

Approximately 8 mL of peripheral venous blood was collected aseptically into two ACD-containing tubes. The blood underwent a double-spin centrifugation process. Quantitative analysis of baseline and post-processing platelet concentration or precise cellular yields was not performed.

4.8 PRP administration

Each patient underwent three intra-articular PRP injections at week 0, week 4 and week 8. Approximately 4 mL of leukocyte-reduced PRP was administered per knee at each session. Leukocyte-reduced PRP was used according to the institutional protocol.

4.9 Outcome measures

Pain severity was assessed using VAS. WOMAC was used to assess pain, stiffness and physical function. Oxford Knee Score was used to assess knee pain and function.

4.10 Follow-up attrition

Assessment time point	Patients with available data	Follow-up rate
Baseline	200	100%
1 month	188	94%
3 months	178	89%
6 months	160	80%

The corresponding attrition rates were 0%, 6%, 11% and 20%, respectively.

4.11 Statistical analysis

Continuous variables were summarized as mean ± standard deviation (SD). For each time point, 95% confidence intervals (CI) for the reported means were calculated as mean ± 1.96 × SD / √n. Percentage change from baseline was calculated descriptively.

4.12 Ethical approval

Ethical approval for the study was obtained from the Institutional Ethics Committee before initiation of the study. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. As this was a retrospective observational study based on institutional clinical records, patient confidentiality and privacy were maintained throughout the study, and all data were analyzed in a de-identified manner.

5. Results

5.1 Baseline characteristics

Characteristic	Value
Eligible patients	200
Male	80 (40%)
Female	120 (60%)
Predominant age group	44–55 years
Unilateral involvement	60 (30%)
Bilateral involvement	140 (70%)
Preferred OA grades	Grade 1 and Grade 2
Selected OA grade	Grade 3

Approximately 210 PRP requisitions per month represents the clinical workload and is distinct from the 200-patient outcome-analysis cohort.

5.2 VAS

Time	n	Mean ± SD	Change from baseline	% change
Baseline	200	8.00 ± 0.57	—	—
1 month	188	5.81 ± 0.64	−2.19	27.38% reduction
3 months	178	4.53 ± 0.62	−3.47	43.38% reduction
6 months	160	3.25 ± 0.67	−4.75	59.38% reduction

5.3 WOMAC

Time	n	Mean ± SD	Change from baseline	% change
Baseline	200	74.84 ± 3.02	—	—
1 month	188	61.25 ± 2.75	−13.59	18.16% reduction
3 months	178	52.72 ± 3.09	−22.12	29.56% reduction
6 months	160	43.53 ± 2.99	−31.31	41.84% reduction

5.4 Oxford Knee Score

Time	n	Mean ± SD	Change from baseline	% change
Baseline	200	19.28 ± 1.80	—	—
1 month	188	24.22 ± 1.26	+4.94	25.62% improvement
3 months	178	27.50 ± 1.05	+8.22	42.63% improvement
6 months	160	30.34 ± 1.45	+11.06	57.37% improvement

5.5 Consolidated outcomes

Outcome	Time point	n	Mean ± SD	95% CI	Change vs baseline / % change
VAS	Baseline	200	8.00 ± 0.57	7.92–8.08	—
VAS	1 month	188	5.81 ± 0.64	5.72–5.90	−2.19 / −27.38%
VAS	3 months	178	4.53 ± 0.62	4.44–4.62	−3.47 / −43.38%
VAS	6 months	160	3.25 ± 0.67	3.15–3.35	−4.75 / −59.38%
WOMAC	Baseline	200	74.84 ± 3.02	74.42–75.26	—
WOMAC	1 month	188	61.25 ± 2.75	60.86–61.64	−13.59 / −18.16%
WOMAC	3 months	178	52.72 ± 3.09	52.27–53.17	−22.12 / −29.56%
WOMAC	6 months	160	43.53 ± 2.99	43.07–43.99	−31.31 / −41.84%
OKS	Baseline	200	19.28 ± 1.80	19.03–19.53	—
OKS	1 month	188	24.22 ± 1.26	24.04–24.40	+4.94 / +25.62%
OKS	3 months	178	27.50 ± 1.05	27.35–27.65	+8.22 / +42.63%
OKS	6 months	160	30.34 ± 1.45	30.12–30.56	+11.06 / +57.37%

Follow-up attrition: 188/200 (94.0%) had 1-month data, 178/200 (89.0%) had 3-month data, and 160/200 (80.0%) had 6-month data. Thus, 6.0%, 11.0%, and 20.0% of the baseline cohort had no documented outcome at these time points, respectively.

VAS decreased by 4.75 points (59.38%) from baseline to 6 months; WOMAC decreased by 31.31 points (41.84%); and OKS increased by 11.06 points (57.37%). The 95% CIs describe uncertainty around each reported mean and are not CIs for within-person change. The six-month results show a consistent directional improvement.

6. Discussion

This retrospective observational study evaluated outcomes following a standardized three-injection regimen of double-spin, leukocyte-reduced PRP in knee osteoarthritis. The principal finding was progressive improvement across pain and functional measures during six months of follow-up.

Mean VAS decreased from 8.00 at baseline to 3.25 at six months, while WOMAC decreased from 74.84 to 43.53 and OKS increased from 19.28 to 30.34. The direction of change across all three measures suggests improvement in both pain and function.

The cohort had a female predominance, with 60% female and 40% male participants, and the predominant age group was 44–55 years. Bilateral involvement was more frequent than unilateral involvement. PRP was preferentially considered for Grade 1 and Grade 2 disease, while selected Grade 3 cases were managed with PRP as part of a broader conservative strategy.

The PRP service workload was approximately 210 requisitions per month, corresponding to an estimated 1,260 requisitions over six months. These figures represent institutional service volume and should not be interpreted as the number of unique patients in the outcome cohort.

The protocol used double-spin preparation with leukocyte-reduced PRP. Evidence regarding leukocyte content remains

mixed; a 2024 double-blind randomized trial reported no clear influence of leukocyte content on safety or efficacy, emphasizing that leukocyte reduction should be reported as a protocol characteristic rather than assumed to confer superiority. Recent systematic-review evidence has reported improvement in VAS and WOMAC outcomes with intra-articular PRP compared with placebo or corticosteroid comparators, while also highlighting heterogeneity between trials.

A further limitation is incomplete characterization of the final PRP product. Platelet concentration, leukocyte concentration, red-cell contamination and exact centrifugation parameters were unavailable. These variables are important for reproducibility and comparison with other studies.

7. Strengths

- Standardized three-injection schedule.
- Double-spin PRP preparation.
- Leukocyte-reduced PRP.
- Standardized approximate injection volume.
- Use of VAS, WOMAC and Oxford Knee Score.
- Six-month longitudinal outcome assessment.
- Real-world clinical cohort and service-volume reporting.

8. Limitations

- Retrospective observational design.
- No placebo or active comparator.
- Incomplete six-month follow-up, with 20% of the baseline cohort lacking documented six-month outcome data.
- Inferential analysis was limited because a verified patient-level longitudinal dataset was not available.
- No quantitative platelet/leukocyte characterization of PRP.
- Concomitant physiotherapy and conservative treatment may have contributed to the observed outcomes.

9. Conclusion

In this retrospective observational cohort, 210 patients were identified for the outcome cohort, of whom 10 were excluded and 200 were included in the final analysis. Three intra-articular injections of double-spin, leukocyte-reduced PRP administered at four-week intervals were associated with progressive improvement in pain and knee function over six months. PRP was preferentially used for Grade 1 and Grade 2 knee osteoarthritis, while selected Grade 3 patients received PRP with physiotherapy and conservative management.

Mean VAS decreased from 8.00 to 3.25, WOMAC from 74.84 to 43.53, and OKS increased from 19.28 to 30.34 between baseline and six months. These findings indicate an association with clinical improvement but do not establish causal efficacy. Prospective controlled studies with standardized PRP characterization and complete patient-level analysis are warranted.

10. Funding

No external funding was received for this study.

11. Ethical Approval

Ethical approval for the study was obtained from the Institutional Ethics Committee before initiation of the study. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. As this was a retrospective observational study based on institutional clinical records, patient confidentiality and privacy were maintained throughout the study, and all data were analyzed in a de-identified manner.

12. Conflict Of Interest

The authors declare no known competing financial interests or personal relationships that could have influenced the work reported in this manuscript.

13. Data Availability

The patient-level dataset is maintained by the institution and may be made available by the corresponding author upon reasonable request, subject to institutional ethics and confidentiality requirements.

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