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Original Research Article

A Prospective Study of Effectiveness of Intra-Articular PRP Injection in Grade 1 and 2 Osteoarthritis of the Knee

Bindusar[1], Rithvika Walad[2]

[1]Senior Resident, Department of Orthopaedics, KoIMS, Madikeri
[2]Assistant Professor, Department of OBG, KoIMS, Madikeri

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Corresponding Author: Dr. Rithvika Walad
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Abstract

Background: Knee osteoarthritis (OA) is a common degenerative joint disorder that causes chronic pain, stiffness, and functional disability. Platelet-rich plasma (PRP), an autologous biological therapy rich in growth factors, has emerged as a promising treatment for early-stage OA by promoting tissue repair and reducing inflammation.

Aim: To evaluate the effectiveness of intra-articular PRP injection in patients with Grade I and Grade II osteoarthritis of the knee.

Materials and Methods: This prospective interventional study was conducted in the Department of Orthopaedics, Kodagu Institute of Medical Sciences (KIMS), Madikeri, Karnataka, from January 2024 to January 2025. Fifty patients aged 40–70 years with Kellgren–Lawrence Grade I or II primary knee osteoarthritis received a single intra-articular PRP injection prepared using the double-spin centrifugation technique. Patients were assessed at baseline, 1 month, 3 months, and 6 months using the Visual Analogue Scale (VAS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), knee range of motion, functional outcome, and treatment-related complications.

Results: The mean age of the participants was 57.8 ± 8.2 years, and females constituted 56% of the study population. The mean VAS score significantly decreased from 7.82 ± 0.91 at baseline to 2.74 ± 0.81 at 6 months ($p<0.001$). The mean WOMAC score improved from 58.64 ± 8.72 to 24.92 ± 5.88 ($p<0.001$). Knee range of motion increased from 109.6 ± 10.4° to 121.4 ± 8.5° ($p<0.001$). Overall, 76% of patients achieved excellent or good functional outcomes. Mild transient pain (6%) and swelling (4%) were the only complications, with no infections or major adverse events reported.

Conclusion: Intra-articular PRP injection is a safe and effective minimally invasive treatment for Grade I and Grade II knee osteoarthritis, providing significant pain relief and functional improvement over six months. PRP may serve as a valuable therapeutic option for early knee osteoarthritis, although larger randomized studies with longer follow-up are required to confirm its long-term efficacy.

Keywords: Knee osteoarthritis, Platelet-rich plasma, PRP, Intra-articular injection, Visual Analogue Scale, WOMAC, Functional outcome.

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Introduction

Osteoarthritis (OA) of the knee is the most common degenerative joint disease and one of the leading causes of chronic pain, disability, and impaired quality of life among middle-aged and elderly individuals worldwide. It is characterized by progressive degeneration of articular cartilage, subchondral bone remodeling, osteophyte formation, synovial inflammation, and varying degrees of joint space narrowing. The disease results in pain, stiffness, reduced range of motion, and functional limitations that significantly affect activities of daily living. The increasing prevalence of obesity, sedentary lifestyles, aging populations, and metabolic disorders has contributed to the growing global burden of knee osteoarthritis, making it an important public health concern.[1] According to the World Health Organization (WHO), osteoarthritis affects more than 500 million people globally, with the knee being the most commonly involved joint. The prevalence increases markedly with advancing age and is higher among women, particularly after menopause, suggesting a hormonal influence in disease progression.[2] In India, knee osteoarthritis represents one of the leading causes of locomotor disability among adults over 40 years of age,

imposing considerable socioeconomic and healthcare burdens.

The pathophysiology of knee osteoarthritis is multifactorial and involves mechanical, biochemical, inflammatory, and genetic factors. Previously considered merely a "wear-and-tear" disease, OA is now recognized as a whole-joint disorder involving cartilage degradation, synovial inflammation, subchondral bone changes, meniscal degeneration, and ligament alterations. Cytokines such as interleukin-1β (IL-1β), tumor necrosis factor-alpha (TNF-α), and matrix metalloproteinases (MMPs) play central roles in cartilage destruction by promoting extracellular matrix degradation while inhibiting cartilage repair mechanisms.[3]

Diagnosis of knee OA is based on clinical symptoms supported by radiographic findings. The Kellgren–Lawrence grading system remains the most widely accepted radiological classification, categorizing OA severity from Grade I to Grade IV based on osteophyte formation, joint space narrowing, sclerosis, and deformity. Early-stage disease (Grades I and II) presents an opportunity for biological interventions aimed at slowing disease progression before irreversible cartilage destruction occurs.[4]

Conventional treatment options include patient education, weight reduction, physiotherapy, exercise programs, analgesics, non-steroidal anti-inflammatory drugs (NSAIDs), intra-articular corticosteroids, and hyaluronic acid injections. Although these therapies effectively reduce symptoms, they primarily provide temporary relief without altering the natural progression of osteoarthritis. Long-term NSAID use is associated with gastrointestinal, renal, and cardiovascular adverse effects, whereas repeated corticosteroid injections may accelerate cartilage degeneration. Consequently, interest has shifted toward regenerative treatment modalities capable of promoting tissue healing rather than simply alleviating symptoms.[5]

Platelet-rich plasma (PRP) has emerged as one of the most promising biological therapies for early osteoarthritis. PRP is an autologous concentration of platelets prepared by centrifugation of the patient's own blood. Activated platelets release numerous growth factors and bioactive proteins, including platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), vascular endothelial growth factor (VEGF), insulin-like growth factor (IGF), fibroblast growth factor (FGF), and epidermal growth factor (EGF). These growth factors stimulate chondrocyte proliferation, enhance extracellular matrix synthesis, suppress inflammatory cytokines, promote angiogenesis, and facilitate tissue repair.[6]

Several randomized controlled trials and systematic reviews have demonstrated that intra-articular PRP injections significantly improve pain, stiffness, physical function, and quality of life in patients with mild-to-moderate knee osteoarthritis compared with hyaluronic acid or placebo. PRP has shown sustained clinical benefits lasting up to 12 months in many studies, particularly among younger patients with early radiographic disease. Additionally, because PRP is autologous, it has a favorable safety profile with minimal risk of allergic reactions or disease transmission.[7]

Despite encouraging evidence, variations in PRP preparation methods, platelet concentration, leukocyte content, injection protocols, and outcome assessment have resulted in heterogeneous findings. Furthermore, relatively limited prospective data are available from Indian populations, particularly from tertiary care teaching hospitals. Standardized clinical studies are therefore necessary to evaluate the effectiveness and safety of PRP therapy in the management of early-stage knee osteoarthritis under local clinical settings.[8]

The present prospective interventional study was conducted at Kodagu Institute of Medical Sciences (KIMS), Madikeri, to evaluate the effectiveness of a single intra-articular platelet-rich plasma injection in patients with Grade I and Grade II osteoarthritis of the knee. Clinical outcomes were assessed using the Visual Analogue Scale (VAS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), knee range of motion, functional outcome, and treatment-related complications over a follow-up period of six months.

Materials and Methods

Study Design and Setting: This prospective, hospital-based interventional study was conducted in the Department of Orthopaedics, Kodagu Institute of Medical Sciences (KIMS), Madikeri, Karnataka, India, over a period of one year from January 2024 to January 2025. The study was undertaken to evaluate the effectiveness of intra-articular Platelet-Rich Plasma (PRP) injections in patients with Grade I and Grade II osteoarthritis (OA) of the knee.

Study Population: A total of 50 patients diagnosed with primary osteoarthritis of the knee were enrolled consecutively after fulfilling the eligibility criteria. Patients were recruited from the outpatient and inpatient services of the Department of Orthopaedics.

Sample Size: The study included 50 patients with symptomatic Grade I and Grade II knee osteoarthritis.

Inclusion Criteria: Patients fulfilling all of the following criteria were included in the study:

- Age between 40 and 70 years.
- Clinical diagnosis of primary knee osteoarthritis.
- Radiological evidence of Grade I or Grade II osteoarthritis according to the Kellgren–Lawrence grading system.
- Persistent knee pain for at least 3 months despite conservative treatment.
- Willingness to participate in the study and provide written informed consent.
- Ability to comply with follow-up visits.

Exclusion Criteria: Patients meeting any of the following criteria were excluded:

- Grade III or Grade IV osteoarthritis.
- Secondary osteoarthritis due to trauma, inflammatory arthritis, infection, or metabolic disorders.
- Previous knee replacement or major knee surgery.
- Active local or systemic infection.
- Coagulation disorders or platelet dysfunction.
- Current anticoagulant therapy that could not be discontinued.
- Hemoglobin<10 g/dL or platelet count <150,000/mm³.
- Pregnancy or lactation.
- History of malignancy.
- Intra-articular steroid or hyaluronic acid injection within the previous 3 months.
- Uncontrolled diabetes mellitus or severe systemic illness.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Ethics Committee of Kodagu Institute of Medical Sciences, Madikeri. Written informed consent was obtained from all participants before enrollment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Baseline Clinical Evaluation: All enrolled patients underwent detailed clinical assessment, including:

- Demographic details (age, gender)
- Body mass index (BMI)
- Occupation
- Duration of symptoms
- Side involved (right/left/bilateral)
- History of previous treatment
- Comorbid illnesses
- Clinical examination of the affected knee
- Range of motion
- Joint line tenderness
- Crepitus
- Swelling and deformity

Radiographs of the knee (standing anteroposterior, lateral, and skyline views) were obtained for grading according to the Kellgren–Lawrence classification.

PRP Preparation: Approximately 20–30 mL of autologous venous blood was collected from each participant under aseptic precautions into anticoagulant-containing tubes.

Platelet-rich plasma was prepared using the double-spin centrifugation technique.

- First centrifugation (soft spin): Separation of plasma from red blood cells.
- Second centrifugation (hard spin): Concentration of platelets to obtain PRP.

Approximately 4–6 mL of platelet-rich plasma was obtained for injection. The PRP preparation was free of visible red blood cell contamination and was prepared immediately before administration under sterile conditions.

Injection Procedure: The affected knee was prepared using standard aseptic techniques. A single intra-articular PRP injection of approximately 5 mL was administered through the lateral parapatellar approach with the knee in slight flexion.

Following injection:

- Patients were observed for approximately 30 minutes.
- Ice application was advised if required.
- NSAIDs were avoided for at least one week after injection.
- Paracetamol was permitted for pain relief.
- Patients were encouraged to perform quadriceps strengthening exercises and lifestyle modifications.
- High-impact activities were avoided for two weeks.

Outcome Measures

Primary Outcome: Clinical improvement was assessed using:

- Visual Analogue Scale (VAS) for pain.
- Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score.

Secondary Outcome

- Knee range of motion.
- Functional improvement.
- Patient satisfaction.
- Adverse events following PRP injection.

Follow-up: Patients were evaluated at the following intervals:

- Baseline (before injection)
- 1 month
- 3 months
- 6 months

At each follow-up visit, the following were recorded:

- VAS pain score
- WOMAC score
- Clinical examination
- Knee range of motion
- Complications or adverse events
- Requirement for additional treatment

Outcome Assessment

Visual Analogue Scale (VAS): Pain intensity was assessed using a 10-cm Visual Analogue Scale ranging from:

- 0 = No pain
- 10 = Worst imaginable pain

WOMAC Score: Functional outcome was evaluated using the WOMAC questionnaire consisting of three domains:

- Pain
- Stiffness
- Physical function

Lower WOMAC scores indicated better functional outcomes.

Data Collection: Data were recorded in a structured case record form specifically designed for the study. Demographic characteristics, clinical findings, radiographic grading, PRP injection details, follow-up assessments, and complications were documented systematically.

Statistical Analysis: Data were entered into Microsoft Excel 2021 and analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range), depending on the distribution of data. Categorical variables were summarized as frequencies and percentages.

Changes in VAS and WOMAC scores between baseline and follow-up visits were analyzed using the paired t-test for normally distributed data or the Wilcoxon signed-rank test for non-normally distributed variables.

Comparisons between Grade I and Grade II osteoarthritis were performed using the independent t-test or Mann–Whitney U test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables.

A p-value <0.05 was considered statistically significant for all analyses.

Results and Observations

A total of 50 patients with Grade I and Grade II osteoarthritis of the knee were included in this prospective study. All patients completed the scheduled follow-up of six months following intra-articular platelet-rich plasma (PRP) injection. The demographic profile, clinical characteristics, and functional outcomes are presented below.

Table 1: Age Distribution of the Study Population (n = 50)

Age Group (Years)	Number of Patients	Percentage (%)
40–49	10	20.0
50–59	20	40.0
60–69	15	30.0
≥70	5	10.0
Total	50	100.0

Observation: The majority of patients (40%) belonged to the 50–59 years age group, followed by 60–69 years (30%). The mean age of the study population was 57.8 ± 8.2 years.

Table 2: Gender Distribution

Gender	Number	Percentage (%)
Male	22	44.0
Female	28	56.0
Total	50	100.0

Observation: Females constituted 56% of the study population, indicating a slightly higher prevalence of early osteoarthritis among women.

Table 3: Body Mass Index (BMI)

BMI Category	Number	Percentage (%)
Normal (<25 kg/m²)	12	24.0
Overweight (25–29.9 kg/m²)	24	48.0
Obese (≥30 kg/m²)	14	28.0
Total	50	100.0

Observation: Nearly three-fourths (76%) of patients were either overweight or obese.

Table 4: Kellgren–Lawrence Grade

OA Grade	Number	Percentage (%)
Grade I	18	36.0
Grade II	32	64.0
Total	50	100.0

Observation: Grade II osteoarthritis was more common, accounting for 64% of cases.

Table 5: Side of Knee Involvement

Side	Number	Percentage (%)
Right	22	44.0
Left	18	36.0
Bilateral	10	20.0
Total	50	100.0

Observation: Right knee involvement was slightly more frequent than left knee involvement.

Table 6: Mean VAS Pain Score During Follow-up

Follow-up	Mean ± SD	p-value*
Baseline	7.82 ± 0.91	—
1 Month	6.01 ± 0.84	<0.001
3 Months	4.32 ± 0.79	<0.001
6 Months	2.74 ± 0.81	<0.001

*Compared with baseline.

Observation: There was a statistically significant reduction in VAS pain scores at every follow-up visit, with maximum improvement observed at six months.

Table 7: Mean WOMAC Score During Follow-up

Follow-up	Mean ± SD	p-value*
Baseline	58.64 ± 8.72	—
1 Month	48.36 ± 7.84	<0.001
3 Months	36.28 ± 6.74	<0.001
6 Months	24.92 ± 5.88	<0.001

*Compared with baseline.

Observation: WOMAC scores showed progressive and statistically significant improvement throughout the study period, indicating enhanced knee function after PRP therapy.

Table 8: Knee Range of Motion (Degrees)

Follow-up	Mean ± SD	p-value
Baseline	109.6 ± 10.4	—
3 Months	116.8 ± 9.1	<0.001
6 Months	121.4 ± 8.5	<0.001

Observation: Mean knee flexion improved significantly from baseline to six months following PRP injection.

Table 9: Overall Functional Outcome at 6 Months

Functional Outcome	Number	Percentage (%)
Excellent	15	30.0
Good	23	46.0
Fair	9	18.0
Poor	3	6.0
Total	50	100.0

Observation: Overall, 76% of patients achieved either excellent or good functional outcomes at the end of six months.

Table 10: Complications Following PRP Injection

Complication	Number	Percentage (%)
None	45	90.0
Mild transient pain	3	6.0
Mild swelling	2	4.0
Infection	0	0.0
Allergic reaction	0	0.0

Observation: PRP injection was well tolerated. Mild transient pain and swelling resolved with conservative management. No major complications or infections were observed.

Discussion

The present prospective interventional study evaluated the effectiveness of intra-articular platelet-rich plasma (PRP) injection in 50 patients with Grade I and Grade II knee osteoarthritis over a follow-up period of six months. The findings demonstrated significant improvement in pain relief, functional outcome, and knee range of motion with an excellent safety profile. These observations support the growing evidence that PRP represents an effective biological treatment for early-stage osteoarthritis.

The mean age of patients in the present study was 57.8 ± 8.2 years, with the majority (40%) belonging to the 50–59-year age group. These findings are consistent with previous epidemiological studies reporting that symptomatic knee osteoarthritis commonly develops after the fifth decade because of cumulative cartilage degeneration and age-related biomechanical changes. Felson et al. similarly observed a marked increase in OA prevalence among individuals older than 50 years.[9]

Females constituted 56% of the study population, reflecting the higher prevalence of knee OA among women. Hormonal changes after menopause, increased obesity, altered biomechanics, and reduced muscle strength have been proposed as contributing factors. The Framingham Osteoarthritis Study also demonstrated a greater prevalence of symptomatic knee osteoarthritis in women than men.[10]

Most patients (76%) in the present study were either overweight or obese, emphasizing the role of increased body mass index as an important modifiable risk factor. Excess body weight increases mechanical stress across the knee joint while adipokines released from adipose tissue promote chronic inflammation and cartilage degradation. Bliddal and Christensen highlighted obesity as one of the strongest independent predictors of both OA development and progression.[11] Grade II osteoarthritis constituted 64% of the study population, indicating that patients usually seek medical attention after the onset of definite radiographic changes rather than during the earliest stage of disease. This observation agrees with reports by Kellgren and Lawrence, who demonstrated that symptomatic patients commonly present with Grade II radiographic changes.[4]

Pain reduction represented one of the most significant outcomes of the present study. The mean VAS score decreased progressively from 7.82 ± 0.91 at baseline to 2.74 ± 0.81 at six months, with statistically significant improvement at every follow-up visit ($p<0.001$). PRP-derived growth factors reduce synovial inflammation, suppress inflammatory mediators such as IL-1β and TNF-α, and stimulate cartilage repair, thereby contributing to sustained pain relief. Similar improvements have been reported by Patel et al., who demonstrated significantly lower pain scores following PRP injections compared with placebo.[12]

Functional improvement was reflected by the marked reduction in WOMAC score from 58.64 ± 8.72 at baseline to 24.92 ± 5.88 at six months. Improvement was observed across all follow-up visits and was statistically significant. Functional recovery following PRP therapy has been attributed to decreased pain, improved joint lubrication, enhanced cartilage metabolism, and restoration of joint biomechanics. Raeissadat et al. similarly reported significant improvement in WOMAC scores following PRP therapy in patients with early knee osteoarthritis.[13]

Range of motion improved significantly from 109.6° at baseline to 121.4° after six months. Improved joint mobility likely resulted from reduced pain, decreased synovitis, and enhanced participation in physiotherapy and quadriceps strengthening exercises. Similar observations were reported by Filardo et al., who demonstrated better joint function and mobility following PRP treatment.[14]

Overall functional outcome was encouraging, with 76% of patients achieving either excellent or good results after six months. These findings support the effectiveness of PRP in delaying symptom progression and improving daily activities in patients with mild-to-moderate osteoarthritis. The outcomes closely resemble those reported by Kon et al., who observed sustained functional improvement following PRP injections over one year of follow-up.[15]

Safety remains one of the major advantages of PRP therapy. In the present study, no major adverse events were observed. Mild transient pain occurred in 6% of patients and mild swelling in 4%, both resolving with conservative treatment. No infections or allergic reactions were encountered. Since PRP is prepared from autologous blood, immunological reactions and disease transmission are virtually eliminated. Similar excellent safety profiles have been consistently reported in systematic reviews evaluating PRP for knee osteoarthritis.[16]

The overall findings indicate that PRP therapy is particularly beneficial in patients with early radiographic osteoarthritis (Grades I and II), where

viable cartilage remains capable of responding to regenerative stimuli. The biological effects of platelet-derived growth factors appear to provide symptomatic relief while potentially modifying disease progression. Although PRP cannot reverse advanced cartilage loss, it may delay the need for more invasive procedures such as total knee arthroplasty in appropriately selected patients.

The present study has certain limitations. The sample size was relatively small, the follow-up duration was limited to six months, and there was no comparison group receiving corticosteroids, hyaluronic acid, or placebo. Platelet concentration within the PRP preparation was also not quantitatively analyzed. Larger multicenter randomized controlled trials with longer follow-up and standardized PRP preparation protocols are required to establish optimal treatment guidelines and evaluate long-term structural benefits.

Overall, the present study demonstrates that a single intra-articular PRP injection significantly improves pain, knee function, and range of motion in patients with Grade I and Grade II osteoarthritis while maintaining an excellent safety profile. PRP therefore represents an effective, minimally invasive, and biologically promising treatment option for early knee osteoarthritis.

Conclusion

A single intra-articular platelet-rich plasma (PRP) injection significantly reduced pain and improved knee function, range of motion, and overall clinical outcomes in patients with Grade I and Grade II knee osteoarthritis over a six-month follow-up. The treatment was safe, with only minor transient adverse effects and no serious complications. PRP appears to be an effective minimally invasive therapeutic option for early knee osteoarthritis, although larger randomized studies with longer follow-up are needed to confirm its long-term efficacy.

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