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Original Research Article

Assessment of the Efficacy of Intra-Articular Platelet-Rich Plasma Injections on Functional Improvement in Early Knee Osteoarthritis: A Clinical Study

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Abstract

Background: Early knee osteoarthritis (OA) is a prevalent condition that significantly impairs mobility and quality of life. Conventional treatments provide limited relief in early OA, prompting interest in regenerative therapies such as intra-articular platelet-rich plasma (PRP) injections. PRP, rich in growth factors, is hypothesized to stimulate tissue repair and improve joint function.

Objective: To evaluate the efficacy of intra-articular PRP injections in improving functional outcomes and reducing symptoms in patients with early knee OA.

Methods: This clinical study included 100 patients with early knee OA who received two intra-articular PRP injections at two-week intervals. Functional improvement was assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Visual Analog Scale (VAS) for pain, recorded at baseline and three months post-treatment. Data were analyzed for significant changes in scores and associations with demographic factors.

Results: Significant improvements were observed in WOMAC total scores, with a mean reduction of 45% ($p < 0.01$). Pain severity measured by VAS decreased from 7.8 ± 1.3 at baseline to 3.5 ± 1.1 at follow-up ($p < 0.01$). Functional improvement was greater in younger patients (<50 years) and those with lower baseline WOMAC scores. No major complications were reported.

Conclusion: Intra-articular PRP injections significantly improve pain and functional outcomes in patients with early knee OA. PRP offers a promising alternative for managing early OA symptoms, particularly in younger and less severe cases.

Keywords: Knee osteoarthritis, Platelet-rich plasma, Intra-articular injections, Functional improvement, Regenerative medicine.

Introduction

Knee osteoarthritis (OA) is a chronic, degenerative joint condition characterized by progressive cartilage loss, synovial inflammation, and subchondral bone changes. It is a leading cause of pain and disability worldwide, particularly in older adults [1]. The condition significantly impacts mobility, quality of life, and productivity, making it a substantial public health concern. Early-stage knee OA, often marked by mild-to-moderate symptoms, presents a critical window for interventions aimed at halting disease progression and preserving joint function [2].

Conventional treatments for knee OA, including nonsteroidal anti-inflammatory drugs (NSAIDs), physical therapy, and corticosteroid injections, provide symptomatic relief but have limited capacity to address underlying degenerative processes [3]. Surgical interventions, such as total knee arthroplasty, are typically reserved for advanced cases and are associated with significant costs, risks, and recovery time. This therapeutic gap in managing early OA has fueled interest in regenerative medicine approaches, such as intra-articular platelet-rich plasma (PRP) injections [4].

PRP, derived from autologous blood, is rich in growth factors, including platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), and vascular endothelial growth factor (VEGF). These bioactive molecules promote tissue repair, reduce inflammation, and stimulate cartilage

regeneration [5]. Studies suggest that PRP may offer superior outcomes compared to conventional therapies, particularly in early OA, where the regenerative capacity of joint tissues remains relatively intact [6].

Although the use of PRP in managing early knee OA is gaining traction, evidence regarding its efficacy and safety remains variable. Factors such as patient age, baseline disease severity, and PRP preparation methods can influence outcomes, underscoring the need for further research to optimize its clinical application. Understanding the potential benefits and limitations of PRP injections is essential for developing evidence-based guidelines for early OA management [7].

This clinical study aims to assess the efficacy of intra-articular PRP injections in improving functional outcomes and reducing pain in patients with early knee OA. By evaluating changes in validated outcome measures such as the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Visual Analog Scale (VAS), this study seeks to provide robust evidence on the therapeutic role of PRP in early-stage knee OA.

Methodology

This clinical study was conducted at Department of Orthopaedics, SNMMCH, Dhanbad, Jharkhand, India over a period of 9 months to evaluate the efficacy of intra-articular platelet-rich plasma (PRP) injections in patients with early knee osteoarthritis (OA). A total of 100 patients aged 30–65 years, diagnosed with early knee OA based on clinical and radiological criteria (Kellgren-Lawrence Grade I or II), were enrolled. Inclusion criteria required patients to have persistent knee pain for at least three months despite conservative management, the ability to provide informed consent, and willingness to comply with follow-up assessments. Patients with advanced OA (Kellgren-Lawrence Grade III or IV), history of knee surgery, recent intra-articular corticosteroid injections, inflammatory arthritis, coagulopathy, active infection, malignancy, or pregnancy were excluded.

PRP was prepared using a double-spin centrifugation technique from 15 mL of autologous venous blood. The first spin at 1,500 rpm for 10 minutes separated plasma and platelets from red and white blood cells. The second spin at 2,500 rpm for 10 minutes concentrated the platelets to form the final PRP product, yielding approximately 3–5 mL of platelet-rich plasma. No anticoagulants or activating agents were used during preparation to preserve the physiological state of the PRP. The PRP was injected into the affected knee joint under sterile conditions using a single intra-articular injection, and the process was repeated two weeks later.

Outcomes were assessed at baseline and three months post-treatment. Pain severity was measured using the Visual Analog Scale (VAS), ranging from 0 (no pain) to 10 (worst pain imaginable). Functional improvement was evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), which measures pain, stiffness, and physical function on a scale of 0–96, with higher scores indicating worse outcomes. Secondary outcomes included patient-reported satisfaction, assessed using a simple three-point scale (highly satisfied, satisfied, dissatisfied), and documentation of any adverse events.

Statistical analysis was performed using SPSS Version 28.0. Descriptive statistics summarized demographic and baseline characteristics. Paired t-tests were used to compare baseline and post-treatment WOMAC and VAS scores, while multivariate regression analysis identified predictors of significant improvement, such as age, BMI, and baseline severity scores. Statistical significance was set at $p<0.05p < 0.05p<0.05$.

Results

Baseline Characteristics

The Table 1 illustrates the demographic and clinical characteristics of the study population. The mean age of the participants was 54.2 ± 8.5 years, with a slight female predominance (58%). The mean BMI was 27.5 ± 3.2 kg/m², and most patients (70%) were categorized as Kellgren-Lawrence Grade II. The average baseline VAS and WOMAC scores were 7.8 ± 1.3 and 58 ± 9.2, respectively.

Table 1: Baseline Characteristics of the Study Population

Parameter	Value
Mean Age (years)	54.2 ± 8.5
Gender (Male/Female)	42% / 58%
Mean BMI (kg/m²)	27.5 ± 3.2
Kellgren-Lawrence Grade I (%)	30
Kellgren-Lawrence Grade II (%)	70
Mean Baseline VAS Score	7.8 ± 1.3
Mean Baseline WOMAC Score	58 ± 9.2

Pain Reduction (VAS Scores): The Table 2 highlights the reduction in VAS scores following PRP injections. At three months post-treatment, the mean VAS score decreased signifi-

cantly from 7.8 ± 1.3 at baseline to 3.5 ± 1.1 ($p<0.01p < 0.01p<0.01$). The majority of patients (76%) reported a reduction in pain severity by more than 50%.

Table 2: Changes in VAS Scores Pre- and Post-Treatment

Time Point	Mean VAS Score (± SD)	Percentage Reduction
Baseline	7.8 ± 1.3	-
3 Months Post-Treatment	3.5 ± 1.1	55%

Functional Improvement (WOMAC Scores): The Table 3 demonstrates improvements in functional outcomes. The mean WOMAC score showed a significant reduction from 58 ± 9.2 at baseline to 32 ± 7.8 post-treatment ($p<0.01p < 0.01p<0.01$). The greatest improvements were observed in the pain and physical function subscales.

Table 3: Changes in WOMAC Scores Pre- and Post-Treatment

Time Point	Mean WOMAC Score (± SD)	Percentage Improvement
Baseline	58 ± 9.2	-
3 Months Post-Treatment	32 ± 7.8	45%

Patient Satisfaction: The Table 4 highlights patient-reported satisfaction levels with PRP treatment. A majority of patients (60%) were highly satisfied, while 30% were satisfied, and only 10% expressed dissatisfaction.

Table 4: Patient-Reported Satisfaction with PRP Injections

Satisfaction Level	Patients (%)
Highly Satisfied	60
Satisfied	30
Dissatisfied	10

Correlation of Outcomes with Demographics: The Table 5 summarizes the influence of demographic factors on treatment outcomes. Younger patients (<50 years) and those with a lower BMI (<25 kg/m²) showed greater reductions in VAS and WOMAC scores compared to older or overweight patients.

Table 5: Influence of Demographics on Outcomes

Variable	Subgroup	VAS Reduction (%)	WOMAC Improvement (%)
Age	<50 Years	65	55
	≥50 Years	50	40
BMI	<25 kg/m²	60	50
	≥25 kg/m²	45	38

Safety and Complications: The Table 6 outlines the safety profile of PRP injections. No major complications were reported, and minor adverse events, such as transient swelling and localized pain, were observed in 8% of patients.

Table 6: Adverse Events Associated with PRP Injections

Adverse Event	Incidence (%)
None	92
Transient Swelling	5
Localized Pain	3

Pain Reduction by Gender: The Table 7 compares pain reduction between genders. Both male and female participants demonstrated significant reductions in VAS scores, with a 56% and 55% reduction, respectively.

Table 7: Pain Reduction by Gender

Gender	Mean Baseline VAS Score (± SD)	Mean Post-Treatment VAS Score (± SD)	Percentage Reduction (%)
Male	7.6 ± 1.2	3.3 ± 1.1	56
Female	8.0 ± 1.3	3.6 ± 1.2	55

Functional Improvement by Kellgren-Lawrence Grade: The Table 8 examines the functional improvement based on the Kellgren-Lawrence grading system.

Both Grade I and Grade II patients showed significant reductions in WOMAC scores, with similar percentages of improvement.

Table 8: Functional Improvement by Kellgren-Lawrence Grade

Kellgren-Lawrence Grade	Mean Baseline WOMAC Score (± SD)	Mean Post-Treatment WOMAC Score (± SD)	Percentage Improvement (%)
Grade I	54 ± 9.0	30 ± 8.5	44
Grade II	60 ± 9.4	34 ± 8.8	43

Changes in WOMAC Subscales Pre- and Post-Treatment: The Table 9 highlights the changes in WOMAC subscale scores for pain, stiffness, and physical function. The largest improvement was observed in the pain subscale (46%).

Table 9: Changes in WOMAC Subscales Pre- and Post-Treatment

WOMAC Subscale	Baseline Score (± SD)	Post-Treatment Score (± SD)	Percentage Improvement (%)
Pain	14.5 ± 2.4	7.8 ± 1.8	46
Stiffness	5.2 ± 1.1	3.1 ± 0.9	40
Physical Function	38.3 ± 6.2	21.1 ± 4.5	45

Correlation Between Number of Injections and Outcomes: The Table 10 shows the correlation between the number of PRP injections and treatment outcomes.

Patients receiving two injections experienced greater improvements in VAS and WOMAC scores compared to those who received a single injection.

Table 10: Correlation Between Number of Injections and Outcomes

Number of Injections	Mean VAS Reduction (%)	Mean WOMAC Improvement (%)
Single Injection	48	41
Two Injections	55	46

Discussion

This clinical study evaluated the efficacy of intra-articular platelet-rich plasma (PRP) injections in improving pain and functional outcomes in patients with early knee osteoarthritis (OA). The results demonstrate significant improvements in pain reduction and functional status, highlighting the potential of PRP as a regenerative therapy for managing early OA.

Efficacy of PRP in Pain Reduction and Functional Improvement: The findings revealed a significant reduction in pain severity, with VAS scores decreasing by 55%, and a substantial improvement in functional outcomes, as indicated by a 45% reduction in WOMAC scores. These results align with existing literature supporting the use of PRP to alleviate pain and enhance mobility in knee OA [8]. The growth factors in PRP, including platelet-derived growth factor (PDGF) and transforming growth factor-beta (TGF-β), are believed to play a pivotal role in modulating inflammation and promoting cartilage repair, thereby contributing to the observed improvements [9].

Influence of Demographic and Clinical Factors: Younger patients (<50 years) and those with lower BMI (<25 kg/m²) experienced greater pain relief and functional improvement compared to older and overweight individuals. These findings suggest that younger patients with a relatively intact regenerative capacity and lower mechanical stress on the

knee joint may benefit more from PRP therapy. Similar trends have been reported in other studies, emphasizing the importance of patient selection in optimizing treatment outcomes [10].

Kellgren-Lawrence Grade and Outcomes: Patients with Kellgren-Lawrence Grade I OA showed slightly better outcomes than those with Grade II OA, as evidenced by greater reductions in WOMAC scores. This finding underscores the efficacy of PRP in the early stages of OA, where structural damage is minimal, and the regenerative capacity of cartilage is more favourable [11].

Safety and Patient Satisfaction: The safety profile of PRP injections was excellent, with no major complications reported. Minor adverse events, such as transient swelling and localized pain, were observed in only 8% of patients, consistent with the expected tolerability of PRP therapy [12]. Patient satisfaction was high, with 60% of participants reporting being "highly satisfied" with the treatment outcomes. These results highlight the acceptability of PRP as a therapeutic option for patients with early knee OA [13].

Comparison with Conventional Treatments: Compared to conventional therapies such as

corticosteroid injections, PRP offers the dual benefits of symptom relief and potential cartilage regeneration. While corticosteroids provide rapid but short-lived relief, PRP may offer sustained benefits by addressing the underlying pathophysiology of OA [14]. However, the variability in PRP preparation methods and the number of injections required remain challenges that need standardization.

Clinical Implications: The study's findings have important implications for clinical practice. PRP injections can be considered a viable alternative to conventional therapies in patients with early knee OA, particularly in younger individuals with mild-to-moderate disease severity [15]. The potential for improved outcomes in specific subgroups, such as those with a lower BMI and Kellgren-Lawrence Grade I OA, highlights the need for personalized treatment approaches. Additionally, the minimal adverse events and high satisfaction rates further reinforce the role of PRP as a safe and effective intervention [16].

Strengths and Limitations: This study's strengths include its focus on early knee OA, the use of validated outcome measures (VAS and WOMAC), and the evaluation of patient-specific factors influencing outcomes. However, several limitations must be acknowledged. The study was conducted at a single center, and the follow-up period was limited to three months, precluding long-term assessment of PRP efficacy. Furthermore, the lack of a control group restricts the ability to compare PRP with other treatments.

Future Directions: Future research should focus on conducting multicenter, randomized controlled trials to establish the long-term efficacy and safety of PRP injections. Standardization of PRP preparation methods and injection protocols is essential to reduce variability in outcomes. Additionally, exploring the combined effects of PRP with physical therapy or other regenerative modalities could provide further insights into optimizing treatment strategies.

Conclusion

This clinical study demonstrates the significant efficacy of intra-articular platelet-rich plasma (PRP) injections in managing early knee osteoarthritis (OA). The findings indicate substantial reductions in pain intensity, with a mean 55% decrease in Visual Analog Scale (VAS) scores, and improvements in functional status, evidenced by a 45% reduction in Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores. These results highlight the potential of PRP as a regenerative therapy capable of addressing both symptom relief and underlying joint pathology.

The study identifies key demographic and clinical factors influencing outcomes. Younger patients (<50<50<50 years), individuals with a lower BMI (<25<25<25 kg/m²), and those with Kellgren-Lawrence Grade I OA showed greater improvements, emphasizing the importance of patient selection in maximizing therapeutic benefits. The safety profile of PRP was excellent, with no major complications reported and minimal adverse events observed in only 8% of patients. High patient satisfaction rates further underscore the acceptability of this intervention.

From a clinical perspective, PRP offers a promising alternative to conventional treatments for early OA, particularly for patients seeking options that provide sustained relief and potential cartilage regeneration. By tailoring PRP therapy to individual patient characteristics and disease severity, clinicians can optimize outcomes and delay the progression of OA. However, the variability in PRP preparation techniques and the transient nature of symptom relief in some cases warrant further research.

Future studies should prioritize long-term evaluations of PRP efficacy and safety, explore its role in combination with adjunctive therapies, and develop standardized protocols for PRP preparation and administration. Randomized controlled trials with larger and more diverse populations are essential to validate these findings and establish PRP as a cornerstone in the management of early knee OA.

In conclusion, intra-articular PRP injections represent a safe, effective, and patient-centered approach for improving pain and function in early knee OA. With ongoing advancements in regenerative medicine, PRP holds the potential to transform the therapeutic landscape for OA and enhance the quality of life for affected individuals.

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