

Evaluating the Impact of Platelet-Rich Plasma Injections on Knee MRI Imaging and Pain Severity in Patients with Knee Osteoarthritis: A Comparative Before-After Study

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KEYWORDS

Platelet rich plasma, Magnetic resonance imaging, Knee, Osteoarthritis

ABSTRACT

Objectives: Knee osteoarthritis affects 40% of people over 70 years old worldwide, making non-surgical treatments like platelet-rich plasma (PRP) injections an essential focus. Recognizing that osteoarthritis impacts all joint components, magnetic resonance imaging (MRI) has become crucial for monitoring treatment effectiveness. Our study examines changes in pain intensity and knee MRI imaging of patients with knee osteoarthritis following PRP injections, contributing to the advancement of non-surgical interventions and improved patient outcomes.

Methods and materials: This interventional before-after study recruited patients with knee osteoarthritis who were referred to physical medicine and rehabilitation and orthopedics clinics at Shahid Rahnamoun and Shahid Sadoughi hospitals in Yazd and were considered suitable candidates for platelet-rich plasma (PRP) injections by specialists. Participants received PRP injections on two separate occasions, spaced one month apart. The study examined three time points: before the PRP injection, one month post-injection, and six months post-injection. MRI findings were assessed before the injection and six months afterward. Patients' pain intensity was evaluated based on Visual Analog Scale (VAS). The collected data were analyzed using SPSS software version 26 with a paired t-test for statistical analysis. The statistical significance threshold was set at $p < 0.05$ for all criteria.

Results: The study involved 25 patients with 36 affected knees (14 patients with one affected knee and 11 patients with two affected knees). The mean age of the participants was 64.27 years, with 3 male patients (12%) and 22 female patients (88%). Comparison of MRI findings six months post-PRP injection to pre-injection revealed no significant changes for most parameters. However, a statistically significant difference was observed in the mean pain intensity score when comparing measurements one month post-injection to pre-injection, six months post-injection to pre-injection, and after the second injection (six months post-injection) to the first injection (one month post-injection) based on the utilized criteria ($p < 0.05$).

Conclusion: In conclusion, the findings of this study indicate that platelet-rich plasma (PRP) injections effectively reduce pain intensity in patients with knee osteoarthritis. However, the treatment does not lead to significant changes in the MRI findings for these patients. Therefore, while PRP injections can be a beneficial therapeutic option for managing symptoms and enhancing patients' daily lives, they may not alter the underlying structural pathology of knee osteoarthritis as visualized on MRI.

I. INTRODUCTION

Knee osteoarthritis (OA) is a widespread degenerative joint disorder associated with chronic pain and functional impairment, affecting millions of individuals globally. According to the Global Burden of Disease Study (GBD), the global prevalence of knee OA in 2017 was

estimated at 3.8% (1). Furthermore, a systematic review and meta-analysis by GBD reported an age-standardized global prevalence of 15% for all-site OA, with knee OA representing a substantial proportion of this burden (2). Additional evidence from a systematic review indicated a pooled prevalence of knee OA of 23.1% among individuals aged 40 years and older (3). In the United States, projections suggest that by 2040, approximately 78.4 million adults aged 18 years and older will be diagnosed with doctor-diagnosed arthritis, with knee OA being a significant contributor (4).

Despite its high prevalence and considerable impact on quality of life, the management of knee OA remains challenging. Current therapeutic strategies primarily focus on symptom relief, with pharmacological interventions targeting pain and inflammation. Surgical options, such as knee replacement, are reserved for advanced cases but are associated with potential risks and complications. These limitations have spurred interest in alternative therapeutic approaches, including platelet-rich plasma (PRP) injections, which may offer a novel avenue for addressing the underlying pathophysiology of OA (5).

PRP is an autologous biologic product derived from a patient's own blood, containing a concentrated mixture of platelets, growth factors, and bioactive molecules. Preclinical studies suggest that PRP may modulate inflammatory processes, promote tissue regeneration, and enhance cartilage repair in OA-affected joints (6, 7). Experimental models have demonstrated PRP's ability to suppress inflammatory mediators, stimulate chondrocyte proliferation, and enhance extracellular matrix synthesis (8). Clinically, several trials have reported promising outcomes, with PRP injections associated with reductions in pain and improvements in joint function among patients with knee OA (9-13).

However, despite these encouraging findings, several questions remain unresolved. Optimal PRP preparation and administration protocols, as well as its long-term efficacy and safety, require further investigation (7). Additionally, the impact of PRP on structural changes in the joint, as assessed through imaging modalities such as magnetic resonance imaging (MRI), remains underexplored. Evaluating imaging outcomes alongside clinical measures may provide deeper insights into disease progression and treatment response.

This study aims to evaluate the effects of PRP injections on pain relief and MRI-based structural changes in patients with knee OA. By comparing pre- and post-intervention outcomes, this research seeks to contribute to the growing body of evidence on PRP therapy and inform clinical decision-making for the management of knee OA.

II. MATERIAL AND METHODS

Study design

This study employed a longitudinal, interventional design with a pre- and post-intervention follow-up approach to assess patient outcomes. The study was approved by the Ethics Committee with specific approval number for the Protection of Human Subjects of Yazd University of Medical Sciences. The costs of this research project were funded by the Research Committee of Yazd University of Medical Sciences and the Vice-Chancellor of Research.

This study was conducted on 25 patients (36 knees) with grade 2 and 3 knee osteoarthritis according to the Kellgren-Lawrence criteria, to evaluate changes in pain severity and MRI findings after PRP injection. Four knees (3 due to failure to attend follow-up MRI or the second PRP injection, and 1 due to death from heart disease) were excluded from the study. In the end, the study was conducted on 36 knees. No injection-related complications were observed in any of the studied samples

Platelet-Rich Plasma (PRP) Injection Procedure

In this study, patients with osteoarthritis were administered two intra-articular injections of platelet-rich plasma (PRP), one month apart. The PRP preparation process involved drawing 35cc of venous blood from the patient's upper limb veins using an 18-gauge butterfly needle, followed by a two-stage centrifugation at 1600 rpm for 10 minutes and 3800 rpm for 6 minutes to separate erythrocytes and sediment platelets, respectively. The extracted 4cc of platelet-rich plasma was then injected into the joint space using a 22-gauge needle under aseptic conditions via a supra-patellar or medial approach.

MRI protocol

The patient was positioned supine with the knee securely placed in the center of the extremity coil, supported by padding within the cylindrical coil for optimal comfort and motion reduction. MRI scans were performed using an AVENTO 1.5 Tesla scanner. During the examination, different sequences were applied according to different sections, such as PDWI-FS and T1-weighted image (T1WI) sequences in the coronal plane, PDWI-FS and T2-weighted image (T2WI) sequences in the sagittal plane, and PDWI-FS and T1WI and T2-weighted image (T2WI)-FS sequences in the axial plane.

The parameters were adjusted as follows: (1) PDWI-FS: time of echo (TE) of 50 ms and time of repetition (TR) of 2600 ms; (2) T1WI: TE of 11 ms and TR of 348 ms; (3) T2WI : TE of 106 ms and TR of 3000 ms; and (4) matrix of 320×320 , field of view of 140 mm, and slice thickness of 4 mm.

Radiologic Assessment

All the information of patient's radiologic images were studied and analyzed by an experienced accurate radiologist with more than 10 years of clinical and academic experience. MRI was employed to evaluate various knee pathologies associated with osteoarthritis, such as Hoffa synovitis, osteophytes, bone marrow edema, joint effusion, patellar tendon alterations, ligament and meniscal abnormalities, peri-articular changes, Baker's cyst, and degenerative cartilage lesions. These findings provide valuable insights into the disease progression and severity. Radiologic assessments were conducted before and 6 months after first platelet-rich plasma (PRP) injection to evaluate the progression of knee osteoarthritis.

Pain Assessment

Pain intensity and function were evaluated using the Visual Analog Scale (VAS), a 100 mm ruler with anchors representing "no pain" (score 0) and "worst pain imaginable" (score 100). Patients marked their pain level on the scale, which was then quantified for analysis. Pain assessments were conducted at three timepoints: before the first PRP injection, one month after the first injection, and six months following the initial injection, to monitor changes in pain levels and function in response to PRP treatment.

Statistical analysis

Data collected for the study was entered into SPSS version 26 (IBM SPSS Inc., Chicago, IL, USA) for analysis. Descriptive statistics, such as percentages, means, and standard

deviations, were utilized. Paired-T tests were conducted to compare mean values before and after the intervention. The significance level for all criteria was set to $p < 0.05$.

III. RESULTS

This study included 25 patients with an average age of 64.27 ± 7.43 years (range: 42-79 years) and an average body mass index (BMI) of 28.33 ± 2.51 kg/m² (range: 23-32). There were 3 male patients (12%) and 22 female patients (88%) in the study.

Table 1- Pain intensity scores based on the Visual Analog Scale (VAS) criteria at three timepoints

Variable	Mean	SD	P value
VAS	pre-injection	69.58	<0.0001
	1 M	51.52	
	pre-injection	69.58	<0.0001
	6 M	36.80	
	1 M	51.52	<0.0001
	6 M	36.80	

Table 1 shows the mean pain intensity scores using the Visual Analog Scale (VAS) at three timepoints: before the PRP injection, one month after the first PRP injection, and six months following the initial injection. Statistical analysis using paired T-tests demonstrated significant reductions in mean pain intensity scores at one month and six months post-injection compared to pre-injection scores. Additionally, a significant decrease in pain intensity scores was observed at six months post-injection when compared to the scores at one month post-injection.

Upon assessing the MRI findings six months post-PRP injection, no changes were observed in Hoffa synovitis, patellar tendon, PCL ligament, lateral meniscus, and peri-articular regions compared to pre-injection scans, as evaluated using the Magnetic Resonance Imaging Osteoarthritis Cartilage Scoring (MOACS) system. However, minor alterations were detected in osteophyte formation, subcortical bone marrow edema, joint effusion, ACL ligament, medial meniscus, Baker's cyst formation, patellofemoral cartilage, and tibiofemoral cartilage. These findings did not indicate substantial improvement or deterioration in the evaluated parameters of knee osteoarthritis. Comprehensive details regarding the specific MRI findings can be found in Table 2.

MRI finding		6 Month after treatment					
		Better		Not changed		Worse	
		number	percent	number	percent	number	percent
hoffa synovitis		-	-	36	100	-	-
osteophyte formation		-	-	35	97.2	1	2.8
subcortical bone marrow edema		7	19.4	20	55.6	9	25
joint effusion		1	2.8	33	91.7	2	5.6
patellar tendon change		-	-	36	100	-	-
ACL ligament change		-	-	35	97.2	1	2.8
PCL ligament change		-	-	36	100	-	-
lateral meniscus change		-	-	36	100	-	-
medial miniscus change		-	-	35	97.2	1	2.8
peri-articular change		-	-	36	100	-	-
Baker's cyst formation		-	-	35	97.2	1	2.8
patellofemoral cartilage change		2	5.6	29	80.6	5	13.9
tibiofemoral cartilage change		3	8.3	31	86.1	2	5.6

Table 2: MRI Findings in Knee Osteoarthritis - Pre- and Post-PRP Injection Comparative Analysis (6-Month Follow-up) Using MOACS System

IV. DISCUSSION

The primary objective of this study was to evaluate the effectiveness of Platelet-Rich Plasma (PRP) therapy in alleviating pain and improving Magnetic Resonance Imaging (MRI) outcomes in patients with knee osteoarthritis. Our findings demonstrated a significant reduction in pain scores at both one and six months post-PRP injection compared to baseline measurements. These results align with previous studies reporting the beneficial effects of PRP in reducing pain associated with osteoarthritis (9–14). Specifically, Filardo et al. (2013) and Oloff et al. (2015) demonstrated that PRP therapy effectively alleviates pain and enhances function in patients with patellar tendinopathy (15, 16), further supporting its potential as a treatment option for musculoskeletal pain management.

However, contrary to our expectations, we observed no significant improvements in most MRI parameters six months after PRP injection. This finding contrasts with the results reported by Raïessadat et al. (2020), who found significant enhancements in both Visual Analog Scale (VAS) scores and imaging outcomes eight months post-treatment in patients receiving two PRP injections (15). Several factors could account for this discrepancy, including variations in study design, patient demographics, and outcome measures. Our study employed a pre-post design with a single PRP injection, whereas Raïessadat et al. utilized a comparative study approach involving two injections in patients with chronic Achilles tendinopathy. These differences suggest that multiple PRP injections may lead to more pronounced pain reduction and improved structural outcomes, emphasizing the potential benefits of repeated PRP treatments for optimizing therapeutic outcomes.

One possible explanation for the absence of MRI-detected improvements in our study is the follow-up duration. Osteoarthritis is a progressive degenerative condition, and structural changes in joint cartilage and surrounding tissues typically manifest over extended periods. The six-month follow-up may have been insufficient to capture meaningful cartilage regeneration, given the slow repair rate in osteoarthritis.

These findings highlight the need for future studies to investigate the optimal timing and frequency of PRP injections. While a single injection provided significant pain relief, repeated injections over a longer period may be required to achieve substantial long-term benefits in both symptom relief and structural joint preservation. Determining the most effective injection regimen, including the number of injections and appropriate intervals, should be a priority for future research to refine PRP treatment protocols and maximize its therapeutic potential.

Furthermore, to achieve more precise imaging of knee cartilage lesions, future studies should consider utilizing higher slice thicknesses than the 4 mm employed in our study. Implementing a higher slice thickness can enhance the detection of subtle cartilage lesions, enabling more accurate evaluations of PRP treatment outcomes and fostering a deeper understanding of its effects on the underlying pathology of osteoarthritis.

The discordance between pain relief and the lack of MRI changes also warrants further exploration of the relationship between symptomatology and joint structure in osteoarthritis. PRP's primary mechanism of action is likely focused on modulating inflammation and alleviating pain rather than directly reversing cartilage degeneration. Thus, while pain reduction is an important clinical outcome, it may not immediately correlate with significant structural improvements. Patients may experience pain relief due to reduced inflammation or changes in the biochemical environment, even without immediate structural repair. Additionally, PRP may exert a more substantial effect on soft tissue components, such as the synovium and ligaments, which are involved in the inflammatory processes of osteoarthritis, rather than directly regenerating cartilage. Future studies should explore the specific tissues affected by PRP, potentially using advanced imaging techniques like magnetic resonance elastography or quantitative T2 mapping, which offer more sensitive measures of tissue composition.

Age was another key factor that could explain some of the variability in outcomes. As mentioned earlier, younger patients tend to respond better to PRP treatment, likely due to a higher regenerative capacity of their tissues (16). Given the age range of participants in our study, with a mean age of 64 years, the regenerative potential of the knee joint may be somewhat limited in this population, which could explain why the structural improvements on MRI were not as pronounced. Future studies might explore age-specific PRP protocols to determine whether younger patients benefit more from PRP treatment, or if modifications in injection frequency or technique could enhance outcomes in older individuals.

Despite the lack of MRI changes in our cohort, the absence of significant adverse effects following PRP treatment is an important finding. The safety profile of PRP, particularly when used in the management of knee osteoarthritis, is well-documented in the literature. Our study further supports this, as none of the participants experienced severe complications or exacerbations of symptoms post-treatment. This highlights PRP as a relatively low-risk intervention, particularly in comparison to more invasive surgical options, which makes it an attractive therapeutic alternative for patients seeking non-surgical management of knee osteoarthritis.

One of the limitations of our study was the absence of a control group, which may have influenced the interpretation of our results. Without a control group, it is challenging to attribute the observed pain reduction solely to the effects of PRP, as other factors, such as the placebo effect or natural fluctuations in symptoms, could have contributed. In future studies, the inclusion of a randomized controlled design would provide more robust evidence of PRP's effectiveness, especially when comparing it to other treatment modalities, such as corticosteroid injections or hyaluronic acid.

Finally, in light of the variability in outcomes observed in this and other studies, it is crucial to further explore patient-related factors that may influence PRP efficacy, including the severity of osteoarthritis, comorbidities, and prior treatment history. Tailoring PRP therapy to individual patient characteristics may enhance the overall success of this treatment modality, particularly in managing chronic conditions like knee osteoarthritis.

V. CONCLUSION

In conclusion, while our study found significant pain relief following a single PRP injection, it did not observe corresponding improvements in MRI outcomes. However, further research is warranted to optimize the timing of MRI scans and the frequency of PRP injections, as well as to elucidate the potential benefits of repeated PRP therapy. By considering factors such as patient age, MRI parameters, and the specific PRP kits used, future studies can provide valuable insights into the intricate relationship between PRP therapy and osteoarthritis. Ultimately, a comprehensive understanding of these factors will contribute to the development of more effective treatment strategies for patients with osteoarthritis and other musculoskeletal conditions, improving their quality of life and overall wellbeing.

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