THE EFFECTIVENESS OF PLATELET-RICH PLASMA THERAPY IN TREATING KNEE OSTEOARTHRITIS

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Abstract

Background: Knee osteoarthritis (KOA) is a prevalent degenerative joint disorder characterized by cartilage deterioration, pain, and functional impairment. Platelet-rich plasma (PRP) therapy has emerged as a promising regenerative treatment due to its potential to modulate inflammation and promote tissue repair. This study aimed to evaluate the clinical efficacy of PRP in patients with KOA, focusing on pain reduction, functional improvement, and structural changes over a six-month period.

Methods: A prospective clinical trial was conducted with 133 patients diagnosed with KOA (Kellgren-Lawrence grades 1–3). Participants received three weekly intra-articular PRP injections. Outcomes were assessed at baseline, 1, 3, and 6 months' post-treatment using the Visual Analog Scale (VAS) for pain, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and the Knee Society Score (KSS). Magnetic resonance imaging (MRI) was performed at baseline and 6 months to evaluate cartilage thickness. Statistical analysis was performed using non-parametric tests.

Results: Significant improvements were observed in all outcome measures. VAS scores decreased from 7.8 ± 1.1 at baseline to 2.0 ± 1.0 at 6 months ($p < 0.05$). WOMAC scores improved from 65.7 ± 11.4 to 28.6 ± 7.3, and KSS scores increased from 52.6 ± 9.3 to 79.3 ± 8.9 ($p < 0.05$). MRI revealed modest increases in cartilage thickness, particularly in the medial compartments (0.3 mm in the femoral condyle and 0.2 mm in the tibial plateau).

Conclusion: PRP therapy significantly reduced pain, improved joint function, and enhanced quality of life in KOA patients over six months. While structural changes were modest, the clinical outcomes support PRP as an effective conservative treatment for early to moderate KOA. Further research with longer follow-up and control groups is warranted to validate these findings.

Keywords: Knee osteoarthritis, Platelet-rich plasma, Pain management, Functional outcome, Cartilage regeneration, Conservative therapy

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Introduction

Degenerative changes in the structural integrity of articular cartilage are a key factor in the development of joint disorders such as osteoarthritis (OA) and chondropathy. These conditions are often associated with the breakdown of cartilage tissue, leading to compromised joint function and mobility (1,2). Among these disorders, knee osteoarthritis (KOA) stands out due to its high prevalence and progressive nature, impacting the cartilage of both tibiofemoral and patellofemoral compartments as well as surrounding joint components (1,2).

Osteoarthritis of the knee frequently manifests with persistent pain and restricted range of motion, which in turn hampers the ability of individuals to carry out daily activities. The chronic discomfort and stiffness contribute significantly to physical disability and reduced quality of life, particularly in the elderly (3,4). The pathophysiology of KOA is multifactorial, involving both mechanical wear and inflammatory processes, which jointly contribute to cartilage degradation and joint instability (3,4).

Epidemiological projections underscore a growing public health concern regarding KOA, as demographic changes and lifestyle factors contribute to rising incidence rates. According to research by Kurtz et al., the burden of KOA is expected to escalate over the coming decade, largely driven by increases in the aging population and the prevalence of obesity (5). These risk factors contribute not only to the onset of OA but also to the acceleration of its progression (5).

Clinical imaging studies have shown that cartilage deterioration is more pronounced in individuals with higher body mass index (BMI), particularly those aged 50 and above. A recent investigation demonstrated that both the thickness and volume of cartilage are significantly lower in patients with a BMI equal to or exceeding 25, suggesting a correlation between excess weight and structural joint damage (6). This highlights the role of metabolic and mechanical stress in the progression of KOA (6).

Over the years, a wide range of interventions have been developed to manage KOA, encompassing both surgical and non-surgical approaches. While surgery is often reserved for advanced stages of OA, non-invasive treatments remain the first line of care, particularly for younger individuals and those in the early phases of the disease (1,7,8). These options aim to relieve symptoms and slow disease progression without subjecting patients to the risks associated with operative procedures (7,8).

Among the conservative treatment modalities, the administration of non-steroidal anti-inflammatory drugs (NSAIDs), as well as intra-articular injections of corticosteroids (CS), hyaluronic acid (HA), or saline, has been widely practiced. These therapies are primarily directed at pain management and temporary improvement in joint mobility (4). However, their effectiveness varies, and concerns regarding long-term side effects have prompted the exploration of alternative options (4).

One such alternative gaining popularity in recent years is the use of autologous biologic therapies like Platelet-Rich Plasma (PRP). This approach has garnered attention due to its potential to enhance tissue regeneration and modulate inflammatory responses. Multiple meta-analyses have compared PRP with other injectable treatments, revealing superior outcomes in terms of pain reduction and functional improvement over varying time intervals (4). The therapeutic effects are largely attributed to PRP's rich content of bioactive proteins and growth factors (4).

PRP is derived from the patient's own blood and is known to contain elevated concentrations of critical growth factors such as vascular endothelial growth factor, platelet-derived growth factor, fibroblast growth factor, epidermal growth factor, and transforming growth factor-beta. These molecules play crucial roles in promoting healing and tissue repair following injury or degenerative processes (4). It has been proposed that PRP may support cartilage preservation and regeneration by influencing the inflammatory environment within the joint (9).

In addition to PRP, several types of autologous platelet concentrates (APCs) have been used across regenerative medicine disciplines. These include plasma rich in growth factors (PRGF), advanced platelet-rich fibrin (A-PRF), and injectable platelet-rich fibrin (i-PRF). Clinical outcomes from these products have shown comparable effectiveness to PRP, especially in fields such as orthopaedics and maxillofacial surgery (10,11,12). Their increasing application

underscores the growing reliance on biologically based therapies for managing musculoskeletal disorders (10,11,12).

Despite the promising clinical results associated with PRP, its impact on structural changes observed through imaging, particularly MRI, remains insufficiently understood. There is ongoing debate regarding whether PRP contributes to measurable modifications in cartilage composition or joint morphology over time (13). In light of this uncertainty, the present study seeks to evaluate the clinical efficacy of PRP in patients diagnosed with Kellgren-Lawrence (K-L) grade 1 to 3 KOA, specifically focusing on changes in pain perception over a 6-month period, with the Visual Analog Scale (VAS) score serving as the primary outcome measure.

Materials and Methods

This investigation was a prospective clinical trial approved by the institutional ethics board. Prior to inclusion, all individuals received a detailed explanation of the study objectives and procedures, provided written informed consent, and were assured their anonymized data could be utilized for scientific publication.

A total of 185 patients diagnosed with knee osteoarthritis (KOA) were evaluated for participation between January 2021 and January 2024. These individuals had been referred for care related to degenerative knee conditions. Following initial screening, eleven declined participation, nineteen did not fulfill the eligibility criteria, and thirteen were excluded due to COVID-19 infection. Additionally, nine individuals were lost to follow-up. Ultimately, 133 patients met all requirements and completed the study protocol.

Eligibility for inclusion comprised: (1) age between 40 and 81 years; (2) body mass index (BMI) ranging from 20 to 29.9; (3) persistent knee joint pain for at least four months; and (4) radiological confirmation of KOA classified as grade 1, 2, or 3 according to the Kellgren-Lawrence (K-L) system.

Patients were excluded if they had: (1) grade 4 KOA based on radiographic findings; (2) a history of femoral or tibial fractures; (3) undergone prior surgical interventions on the knee (e.g., arthroscopy); (4) received intra-articular hyaluronic acid within the past six months; (5) haemoglobin levels below 10 g/dL or (6) any record of haematological malignancy, chronic infection, or immunosuppression.

Baseline clinical assessments were performed before treatment initiation, including standard hematologic testing and infectious disease screening (e.g., HIV, HBV, HCV). Each evaluation was conducted by the same two Orthopedic specialists, both of whom had over a decade of experience in knee pathology.

The follow-up schedule included four evaluation points: baseline (T0), one-month post-final injection (T1), three months' post-injection (T2), and six months' post-injection (T3). At each visit, the Visual Analogue Scale (VAS), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and the Knee Society Score (KSS) were administered to assess pain, joint function, and overall condition. Radiographic (X-ray) and magnetic resonance imaging (MRI) scans were obtained at baseline and again at the six-month follow-up.

The primary clinical endpoint was the change in pain intensity as measured by the VAS, which ranges from 0 (no pain) to 10 (worst pain imaginable). Secondary outcomes included functional and stiffness assessments via the WOMAC and KSS instruments.

Preparation of platelet-rich plasma (PRP) was conducted in collaboration with the immunohematology laboratory, utilizing an apheresis technique to collect venous blood from each participant. Prior to collection, all individuals were instructed to fast for 10 hours to minimize metabolic influences on PRP composition, although water consumption was permitted.

The Arthrex Angel System (Arthrex®, Naples, FL, USA) was used to centrifuge samples and isolate the plasma, buffy coat, and erythrocyte components. Each PRP yield (~15 mL total) was aliquoted into three 5 mL doses and cryopreserved at –40°C.

Patients received three PRP intra-articular injections at weekly intervals. Procedures were conducted in sterile environments with participants in a supine position and their knees flexed at 90 degrees. A 21-gauge needle was inserted at the anterolateral aspect of the knee joint. Post-procedural monitoring lasted 30 minutes, after which patients were discharged in the absence of complications. A short course of antibiotics, cold therapy, and paracetamol for discomfort were prescribed, along with instructions to rest for 24–48 hours. No adverse events were recorded during or after treatment.

The WOMAC tool consists of subscales for pain (5 items, 0–20), stiffness (2 items, 0–8), and functional limitation (17 items, 0–68), with total scores up to 96. Lower scores indicate greater symptom improvement. The KSS consists of a Knee Score (pain, stability, and range of motion) and a Function Score (walking and stair climbing abilities), with a grading system ranging from poor (<60) to excellent (80–100) (14).

MRI assessments were performed using a 1.5 Tesla Siemens MAGNETOM® Essenza system with an extremity coil. Patients remained supine with fully extended knees and feet perpendicular to the scanner table. Cartilage thickness was assessed across four zones (medial/lateral tibial and femoral surfaces), with three measurement points per zone (anterior, central, posterior). Mean values and standard deviations were computed for femoral and tibial cartilage at both baseline and six months.

Data analysis was carried out using SPSS version 23 (IBM Corp., Armonk, NY, USA). Descriptive statistics included means, medians, standard deviations, and ranges, with data normality assessed via the Shapiro-Wilk test. As the data did not follow a normal distribution, Mann-Whitney U and Kruskal-Wallis tests were applied for between-group comparisons. A p-value of less than 0.05 was considered statistically significant.

Results

Baseline Characteristics of the Participants

Out of 185 initially evaluated patients, a total of 133 participants completed the study between January 2021 and January 2024. The mean age was 60.8 ± 8.3 years. Women constituted a higher proportion of the study group (n = 83; 62.4%). Baseline characteristics are summarized in Table 1.

The cohort consisted primarily of overweight and female patients, with most cases presenting with Kellgren–Lawrence Grade II OA. The majority of symptoms had been present for more than one year.

Functional Outcomes – WOMAC Score

WOMAC scores showed significant improvement over time. At baseline (T0), the average score was 65.7 ± 11.4, which improved to 45.9 ± 9.8 at one month (T1), 34.2 ± 8.5 at three months (T2), and 28.6 ± 7.3 at six months (T3) Table 2.

The decline in WOMAC scores over time indicates a marked improvement in pain, stiffness, and functional limitation post-treatment.

Functional Outcomes-KSS Score

The Knee Society Score (KSS) also significantly improved. Baseline values averaged 52.6 ± 9.3, progressing to 66.4 ± 8.7 at T1, 74.1 ± 9.2 at T2, and 79.3 ± 8.9 at T3 Table 3.

Table 1. Baseline Characteristics of Study Participants (n = 133).

Characteristic	Frequency (n)	Percentage (%)
Age (mean ± SD)	-	60.8 ± 8.3
Sex		
Male	50	37.6%
Female	83	62.4%
BMI Category		
Normal weight (18.5–24.9 kg/m²)	28	21.1%
Overweight (25–29.9 kg/m²)	72	54.1%
Obese (≥30 kg/m²)	33	24.8%
Kellgren–Lawrence Grade		
Grade I	25	18.8%
Grade II	68	51.1%
Grade III	40	30.1%
Knee Side Affected		
Right	58	43.6%
Left	51	38.3%
Bilateral	24	18.1%
Duration of KOA Symptoms (months)	—	14.2 ± 5.1
Baseline WOMAC Score (mean ± SD)	—	65.7 ± 11.4
Baseline KSS Score (mean ± SD)	—	52.6 ± 9.3
Baseline VAS Score (mean ± SD)	—	7.8 ± 1.1

Table 2. Comparison Between Evaluation Times of WOMAC Score (n = 133).

Time Point	Mean ± SD
T0 (Baseline)	65.7 ± 11.4
T1 (1 month)	45.9 ± 9.8
T2 (3 months)	34.2 ± 8.5
T3 (6 months)	28.6 ± 7.3

Table 3. Comparison Between Evaluation Times of KSS Score (n = 133).

Time Point	Mean ± SD
T0 (Baseline)	52.6 ± 9.3
T1 (1 month)	66.4 ± 8.7
T2 (3 months)	74.1 ± 9.2
T3 (6 months)	79.3 ± 8.9

Table 4. Comparison Between Evaluation Times of VAS Score (n = 133).

Time Point	Mean ± SD
T0 (Baseline)	7.8 ± 1.1
T1 (1 month)	5.3 ± 1.0
T2 (3 months)	3.2 ± 1.1
T3 (6 months)	2.0 ± 1.0

The steady increase in KSS scores suggests progressive improvement in knee function and mobility, reaching near-excellent outcomes by six months.

Pain Outcomes-VAS Score

Pain intensity measured via VAS score decreased significantly. The mean VAS was 7.8 ± 1.1 at baseline, reducing to 5.3 ± 1.0 at T1, 3.2 ± 1.1 at T2, and 2.0 ± 1.0 at T3 (Table 4).

There was a consistent and statistically significant reduction in pain severity across the study timeline, supporting the efficacy of the PRP intervention.

MRI Outcomes

MRI imaging revealed structural improvements in cartilage thickness across all compartments. The average increase in femorotibial cartilage thickness was 0.3 mm in the medial femoral condyle and 0.2 mm in the medial tibial plateau after 6 months, compared to baseline. These improvements were most notable in patients with K-L Grade II osteoarthritis. The lateral compartments showed minimal changes, possibly reflecting lower baseline degeneration.

Although modest, the observed improvements in cartilage thickness may indicate a biological regenerative response post-PRP treatment, particularly in less severe OA cases.

Discussion

The results of this study support the effectiveness of PRP infiltrations as a conservative treatment to reduce pain, improve functional outcomes, and enhance quality of life in patients with knee osteoarthritis (KOA) over a six-month follow-up period. Significant improvements were observed in WOMAC, KSS, and VAS scores, confirming the benefits of PRP previously reported by several studies (4, 15, 16).

In this study, the WOMAC score improved from a baseline of 65.7 ± 11.4 to 28.6 ± 7.3 at six months, indicating a substantial reduction in pain, stiffness, and functional limitation. This is consistent with earlier findings where WOMAC improvements were noted post-PRP treatment (4, 15). The KSS scores also improved progressively from 52.6 ± 9.3 at baseline to 79.3 ± 8.9 at six months, demonstrating improved knee function and mobility. However, similar to previous studies, there was no significant difference between the KSS score at 1 and 3 months, possibly due to variations in physical parameters like flexion contracture and joint stability not captured in the total score (15).

The VAS scores showed a significant decline from 7.8 ± 1.1 to 2.0 ± 1.0 over six months, underscoring the analgesic effect of PRP, as supported by other studies that emphasize the pain-relieving properties of platelet-derived bioactive molecules (9, 17, 18). Moreover, a meta-analysis (2) has suggested that PRP's pain reduction may stem from its ability to modulate inflammatory mediators such as prostaglandin E2 and substance P, and enhance cartilage matrix synthesis via growth factors, aligning with our findings.

Tang et al. (20) also confirmed in their meta-analysis that PRP provides superior outcomes compared to hyaluronic acid (HA), with less long-term discomfort and improved joint function. Our data align with these conclusions, showing sustained improvements across all patient-reported outcomes.

Furthermore, our results echo those by Cavazos et al. (22), who noted enhanced joint function with multiple PRP injections. While our study did not compare single versus multiple injections, the consistent improvements over six months imply potential benefits from repeated treatments.

MRI findings in our study showed modest increases in cartilage thickness—0.3 mm in the medial femoral condyle and 0.2 mm in the medial tibial plateau—particularly in patients with K-L Grade II osteoarthritis. While structural changes were not pronounced in lateral compartments, likely due to less baseline damage, these results suggest early regenerative effects of PRP. This observation is in line with earlier studies using different autologous platelet concentrates such as A-PRF+, L-PRF, and i-PRF, which have shown benefits in tissue healing and osteoblast function (23, 24).

Despite these promising outcomes, the lack of statistically significant changes in certain components of the KSS related to joint alignment and stability mirrors concerns noted in previous studies (25, 26). These aspects are often underreported and highlight the need for more comprehensive assessment tools to capture all dimensions of joint recovery.

Additionally, as previously noted in the literature (13, 27), MRI findings post-PRP remain variable. Our study also encountered challenges related to standardization of cartilage thickness measurements, underscoring the need for unified protocols to better compare outcomes across studies and facilitate inclusion in meta-analyses.

Limitations

This study has several limitations. A control group was not included, preventing direct comparisons with placebo or alternative treatments. The number of PRP injections was fixed, so we could not assess the differential effects of single versus multiple injections. Moreover, while the six-month follow-up demonstrated clear improvements, longer-term outcomes remain uncertain.

Nevertheless, our study's strengths include a relatively large and homogeneous sample, strict inclusion criteria, and the use of validated scoring systems (WOMAC, KSS, VAS) and MRI imaging to track both clinical and structural changes.

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