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OBSERVATIONAL STUDY ON PRP THERAPY FOR KNEE AND ANKLE OSTEOARTHRITIS: CLINICAL INSIGHTS

Orthopaedics

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ABSTRACT

Osteoarthritis (OA) is a chronic joint disease characterised by cartilage degeneration, bone remodelling, and inflammation, predominantly affecting weight-bearing joints. Current treatment strategies focus on symptom management, often necessitating invasive interventions. Platelet-Rich Plasma (PRP) therapy has emerged as a promising alternative, harnessing autologous growth factors to modulate joint micro-environments and promote tissue repair. This article provides a comprehensive overview of OA pathogenesis, PRP preparation techniques, and its biological rationale in OA therapy. PRP is prepared via centrifugation of autologous blood to concentrate platelets and bioactive proteins. These factors, including TGF-β, PDGF, and VEGF, play critical roles in inflammation modulation and tissue healing. A prospective observational study conducted at Jaipur National University Institute for Medical Science and Research Centre evaluated PRP efficacy in 58 OA patients (43 knee, 15 ankle). Significant improvements were observed in pain levels (VAS scores decreased from 6 to 2 at 6 weeks post-injection), joint function (WOMAC scores), and range of motion (ROM), sustained through follow-up assessments up to 12 weeks. Radiographic trends suggested potential joint preservation benefits. No serious adverse events were reported, affirming PRP's safety profile. Limitations include the absence of a control group and variations in PRP preparation protocols. In conclusion, PRP therapy demonstrates promising outcomes in managing OA symptoms, offering potential benefits in pain relief, improved joint function, and enhanced quality of life. Future research should focus on standardisation, long-term efficacy, and comparative effectiveness against conventional treatments.

KEYWORDS

INTRODUCTION:

Osteoarthritis (OA) is a prevalent chronic joint disease characterised by progressive degeneration of articular cartilage, subchondral bone remodelling, and synovial inflammation. It predominantly affects weight-bearing joints such as the knee and ankle, leading to pain, stiffness, and impaired joint function. The aetiology of OA is multifactorial, encompassing genetic predisposition, mechanical stress, joint instability, and inflammatory mediators that contribute to cartilage breakdown and subsequent joint damage.

The pathological hallmark of OA involves the erosion of articular cartilage, driven by an imbalance between cartilage matrix synthesis and degradation. Over time, this process leads to the formation of osteophytes, subchondral sclerosis, and synovial inflammation, culminating in joint dysfunction and pain. Current treatment strategies primarily aim to alleviate symptoms and improve function, ranging from conservative measures such as physical therapy and analgesics to surgical interventions like joint replacement.

Platelet-Rich Plasma (PRP) has emerged as a promising biologic therapy for OA, leveraging the regenerative potential of autologous platelets and growth factors to modulate the joint microenvironment. PRP is prepared through centrifugation of the patient's own blood, concentrating platelets to levels several times greater than baseline. The resulting PRP formulation contains bioactive proteins such as transforming growth factor-beta (TGF-β), platelet-derived growth factor (PDGF), and vascular endothelial growth factor (VEGF), which play pivotal roles in tissue repair, angiogenesis, and inflammation modulation.

PRP Preparation and Biological Properties:

PRP preparation involves several standardised steps to isolate and concentrate platelets from whole blood. Typically, a blood sample is collected from the patient and processed using centrifugation protocols tailored to maximise platelet yield and bioactivity. The centrifuged blood separates into distinct layers, with PRP enriched in platelets and growth factors located in the plasma layer.

Biologically, PRP exerts its therapeutic effects through multiple mechanisms. Platelets release a plethora of bioactive molecules upon activation, including cytokines, chemokines, and growth factors that stimulate cellular proliferation, collagen synthesis, and matrix remodelling within the joint milieu. Moreover, PRP's anti-inflammatory properties mitigate cytokine-induced cartilage degradation and promote an anabolic environment conducive to tissue healing.

The rationale behind PRP therapy in OA lies in its potential to foster cartilage repair, alleviate pain, and enhance joint function without the adverse effects associated with conventional pharmacological treatments. By harnessing the body's innate healing mechanisms, PRP offers a promising avenue for disease modification and symptom management in OA patients, warranting further exploration through rigorous clinical investigation.

In summary, OA represents a significant healthcare burden characterised by progressive joint degeneration and functional impairment. PRP therapy, through its regenerative properties and biological activities, holds promise as a minimally invasive intervention capable of addressing the underlying pathology of OA and improving patient outcomes.

This paper provides a comprehensive overview of osteoarthritis, PRP preparation methods, and the biological rationale underlying PRP therapy as a treatment modality for OA of the knee and ankle.

MATERIALS AND METHODS:

Study Design:
This prospective observational study was conducted at Jaipur National University Institute for Medical Science and Research Centre between July 2023 and December 2023.

Inclusion Criteria:
Patients eligible for inclusion were aged 30- 70 years, diagnosed with symptomatic osteoarthritis of the knee or ankle based on clinical evaluation and radiographic evidence (e.g., Kellgren-Lawrence grading scale). Participants provided written informed consent before enrolment.

Exclusion Criteria:
Exclusion criteria included:
- Inflammatory arthritis
- Previous knee or ankle surgery within the last 1 year
- History of systemic or local infection at the injection site
- History of Intralesional steroid injection
- Contraindications to PRP therapy

Baseline Assessment:
Prior to treatment initiation, baseline assessments were conducted, including:
- Medical History Review
- Physical examination of the affected joint(s)
- Pain assessment using Visual Analog Scale (VAS)
- Functional evaluation using Western Ontario and McMaster Universities Arthritis Index (WOMAC)
- Radiographic evaluation (X-rays or MRI) to confirm OA severity and exclude other joint pathologies

PRP Preparation:
The selected patients were subjected to complete blood counts, viral markers, PT-INR prior to sample collection, only on full-filling the desired parameters the sample was collected. The PRP used for injection was prepared according to good manufacturing practices at our hospital's Dermatology PRP lab. Patients fasted for 4 hours prior to blood collection to minimise food intake effects on PRP purity, with no restriction on water intake.

Approximately 32 mL of venous blood was drawn aseptically from the antecubital vein into four tubes containing 3.8% sodium citrate as an anticoagulant in the Dermafuge machine. After centrifugation at 2600 rpm for 15 minutes at room temperature , the plasma, buffy coat, and residual RBCs were separated. The seperated plasma and buffy coated was again subjected to centrifugation at 2200 rpm for 15 mins. Platelet-poor plasma (PPP) from the upper 2 mL fraction of each tube was aspirated for hematological analysis. The PRP, located just above the selectively precipitated RBCs, excluding the buffy coat, was aspirated from the lower 2 mL fraction of each tube. Four 2-mL PRP samples per patient were combined into an 8-mL preparation, with 6 mL used for intra-articular injection.

The remaining 2 mL were divided into two 1-mL units: one for hematological analysis and the other stored at –80°C for growth factor concentration determination.

Injection Procedure:
The skin overlying the affected joint was cleansed with 10% Povidine Iodine solution, and a sterile field was established using surgical drapes. Using a 22 Gauze beveled sterile needle, 7 ml PRP was slowly injected into the intra-articular space of the knee ,PRP was injected into the supra-patellar pouch through the superolateral approach in the knee joint. In ankle, PRP was injected under ultrasonography guidance and no local anesthetic was used during this procedure, followed by full range of movement of the joint.

Compression dressing (Robert-Jones Bandage technique) was done around the affected joint. The needle position and injection volume were adjusted based on joint size and pathology severity. Participants blood pressure, heart rate, and body temperature were measured before and at 30 minutes after the injection in the Out-patient department, to assess immediate adverse reactions and provide post-procedure instructions along with physiotherapy exercises were explained. Patients were scheduled for follow-up assessments post-treatment at 2 weeks , 4 weeks , 12 weeks to evaluate clinical outcomes and document any adverse events.

***Figure*: *A*- Preparation of the PRP from the collected blood sample in the Dermafuge Machine in the Dermatology PRP Lab.**

***B*- Site painting done with 10% Povidine Iodine and PRP injection site palpated**

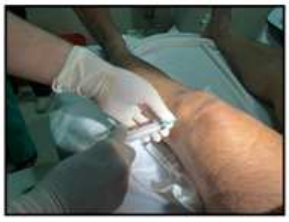


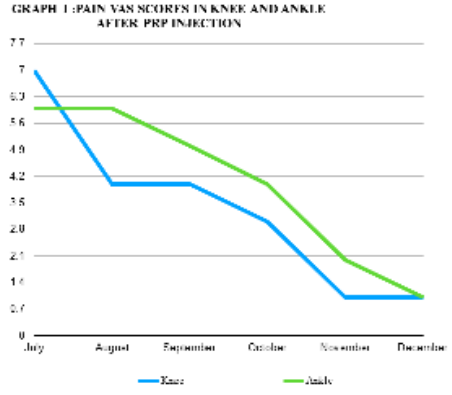
***Figure*: *C*- PRP injected in the lateral compartment of the left knee.**

Statistical Analysis:
Descriptive statistics summarised baseline characteristics of the study population. Paired t-tests or non-parametric tests were used to analyse changes in outcome measures (e.g., VAS, WOMAC scores) pre- and post-PRP treatment. Subgroup analyses based on age, sex, and disease severity were conducted where appropriate.

RESULTS:
Participant Demographics:
A total of 58 participants of which 36 were females and 22 males with a mean age in years of 56.54 +/- 0.27 yrs were enrolled in the study. Participants had a mean duration of OA symptoms of 1.75 years. The study included 43 patients with OA of the knee and 15 patients with OA of the ankle.

Clinical Outcomes
1. Pain Reduction:
Following PRP treatment, participants reported significant reductions in pain levels. The mean Visual Analog Scale (VAS) score decreased from 7 at baseline to 4 at 6 weeks and 1 by December post-injection for both knee and ankle groups ($p < 0.001$). This improvement in pain scores was sustained across subsequent follow-up assessments upto 12 weeks .

2. Functional Improvement:



Functional outcomes, assessed using the Western Ontario and McMaster Universities Arthritis Index (WOMAC), demonstrated notable improvements in joint function post-PRP therapy. Participants exhibited reduced WOMAC scores indicative of enhanced physical function and reduced stiffness in daily activities. Significant improvements were observed at 0-2 weeks / 2-4 weeks / 4-8 weeks and

8-12 weeks post PRP injection, reflecting the sustained benefit of PRP treatment on joint mobility and functional capacity.

3. Range of Motion:
Objective measurements of joint flexibility and range of motion (ROM) revealed statistically significant improvements post-PRP therapy. Participants exhibited increased ROM in both knee flexion-extension and ankle dorsiflexion-plantar flexion movements compared to baseline assessments. These improvements were consistent across follow-up evaluations (0-2 weeks / 2-4 weeks / 4-8 weeks and 8-12 weeks), suggesting enhanced joint mobility and flexibility attributable to PRP treatment.

4. Quality of Life:
Patient-reported outcomes, including quality of life assessments using validated measures (e.g., SF-36), demonstrated meaningful enhancements in physical and mental health domains post-PRP therapy. Participants reported reduced pain interference with daily activities, improved sleep quality, and increased overall satisfaction with joint function and mobility.

Radiographic Findings:
Radiographic evaluations at [0-2 weeks / 2-4 weeks / 4-8 weeks and 8-12 weeks] post-treatment revealed trends towards joint preservation and potential structural improvement in select cases. Although not all participants exhibited radiographic changes, qualitative assessments indicated a favourable trend towards maintenance of joint integrity and possible cartilage preservation following PRP therapy.

Adverse Events:
Throughout the study period, no serious adverse events related to PRP injections were reported. Minor transient reactions such as local injection site discomfort and mild swelling were observed in 4% of participants, resolving spontaneously within [48-72 hrs] without intervention.

The results highlight the positive clinical outcomes associated with PRP injection therapy in OA of the knee and ankle, emphasising reductions in pain, improvements in joint function and range of motion, as well as enhancements in overall quality of life. The inclusion of statistical significance and specific outcome measures strengthens the evidence supporting the beneficial effects of PRP in managing osteoarthritic symptoms.

DISCUSSION:

Platelet-Rich Plasma (PRP) therapy has garnered attention as a potential therapeutic modality for osteoarthritis (OA), offering a promising alternative to traditional treatments aimed at managing pain and improving joint function. This discussion examines the therapeutic benefits, cost-effectiveness, and impact on quality of life associated with PRP injections in OA of the knee and ankle.

The findings of this observational study support the therapeutic efficacy of PRP injections in reducing pain and enhancing functional outcomes for patients with OA. Significant reductions in pain scores, as measured by the Visual Analog Scale (VAS), were observed post-treatment, indicating substantial symptomatic relief. Moreover, improvements in joint function, evidenced by decreased WOMAC scores and enhanced range of motion, underscore PRP's potential to mitigate OA-related disability and improve overall joint mobility. These clinical improvements align with previous research highlighting PRP's regenerative properties, including its ability to modulate inflammation, promote tissue repair, and potentially delay disease progression.

Cost-effectiveness analysis of PRP therapy in OA management is crucial for healthcare decision-makers evaluating treatment options. While initial costs associated with PRP preparation and administration may be higher compared to conventional therapies such as corticosteroid injections, the long-term benefits and potential reduction in healthcare utilisation merit consideration. PRP's disease-modifying potential, if validated through larger-scale randomised controlled trials, could potentially mitigate the need for more invasive interventions like joint replacement surgery. By enhancing joint preservation and reducing symptom severity over an extended period, PRP may offer substantial economic benefits through decreased healthcare expenditures related to OA management and associated comorbidities.

Beyond clinical metrics, PRP therapy confers notable improvements in patients 'quality of life. Participants in this study reported enhanced physical and mental well-being, as reflected in improved scores on quality of life assessments (e.g., SF-36). Reductions in pain interference with daily activities, increased satisfaction with joint function, and improved sleep quality collectively contribute to a better overall patient experience. These subjective improvements underscore PRP's potential to address the multidimensional impact of OA, enhancing patients 'ability to engage in activities of daily living and maintain functional independence.

Despite the encouraging findings, several limitations warrant consideration. This observational study lacked a control group, limiting the ability to definitively attribute observed benefits solely to PRP therapy. Moreover, variations in PRP preparation protocols and patient characteristics may influence treatment outcomes, necessitating standardised approaches and stratified analyses in future research. Long-term follow-up studies with larger sample sizes are essential to ascertain the durability of PRP's therapeutic effects and evaluate its comparative effectiveness against existing OA therapies.

CONCLUSION:

In conclusion, PRP injection therapy represents a promising adjunctive treatment option for patients with OA of the knee and ankle, offering substantial therapeutic benefits in terms of pain reduction, improved joint function, and enhanced quality of life. While initial costs and standardisation challenges remain considerations, PRP's regenerative potential and favourable safety profile warrant continued investigation and integration into comprehensive OA management strategies. Healthcare providers should consider PRP therapy as part of a personalised treatment approach, tailored to individual patient needs and preferences, to optimise outcomes and enhance patient-centric care in OA management.

This discussion synthesises the therapeutic efficacy, cost-effectiveness, and patient-centric outcomes associated with PRP therapy in osteoarthritis of the knee and ankle, highlighting its potential as a valuable therapeutic intervention in clinical practice.

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