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Original Research

The Role of Platelet-Rich Plasma Therapy in Promoting Tissue Regeneration and Healing in Musculoskeletal Injuries

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ABSTRACT

Background: Platelet-Rich Plasma (PRP) therapy has emerged as a promising regenerative technique in musculoskeletal medicine. PRP is an autologous preparation enriched with platelets, growth factors, and bioactive molecules that promote tissue regeneration and accelerate healing. Despite its widespread application, the precise mechanisms and effectiveness of PRP in treating musculoskeletal injuries remain under investigation.

Materials and Methods: A prospective study was conducted on 50 patients aged 20–50 years with musculoskeletal injuries, including ligament tears, tendon injuries, and muscle strains. PRP was prepared by centrifuging the patient's blood to achieve a platelet concentration of approximately 5x baseline. Patients were administered PRP injections at the injury site under ultrasound guidance. Outcomes were assessed using visual analogy scale (VAS) scores for pain and functional improvement using a validated Musculoskeletal Function Scale (MFS) at baseline, 4 weeks, and 12 weeks post-treatment.

Results: Patients demonstrated significant improvement in pain and functional outcomes. The mean VAS score decreased from 7.5 ± 1.2 at baseline to 3.2 ± 0.8 at 4 weeks and 1.8 ± 0.5 at 12 weeks ($p < 0.05$). MFS scores improved from 40.3 ± 5.1 to 75.6 ± 4.7 at 12 weeks. No significant adverse effects were reported. PRP therapy was particularly effective in tendon injuries compared to ligament and muscle injuries.

Conclusion: PRP therapy effectively promotes tissue regeneration and accelerates healing in musculoskeletal injuries, with significant improvements in pain and function. The treatment is safe, minimally invasive, and holds promise for broader clinical application. However, further large-scale studies are necessary to standardize protocols and confirm long-term benefits.

Keywords: Platelet-Rich Plasma, Tissue Regeneration, Musculoskeletal Injuries, Pain Management, Growth Factors, Tendon Healing.

INTRODUCTION

Musculoskeletal injuries, encompassing ligament tears, tendon injuries, and muscle strains, are among the most prevalent conditions affecting individuals of all age groups. These injuries significantly impact daily activities, quality of life, and productivity, posing a substantial burden on healthcare systems worldwide [1]. Traditional treatment approaches, including rest, physical therapy, and pharmacological interventions, often provide symptomatic relief but may not adequately address the underlying tissue damage or facilitate optimal healing [2].

Recent advancements in regenerative medicine have introduced Platelet-Rich Plasma (PRP) therapy as a potential solution to these challenges. PRP is an autologous preparation derived from the patient's blood, enriched with a high concentration of platelets and associated growth factors. These components are crucial for initiating and sustaining the processes of tissue repair and regeneration [3]. Growth factors, such as platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), and vascular endothelial growth factor (VEGF), play pivotal roles in cellular proliferation, angiogenesis, and extracellular matrix remodelling[4].

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Studies have demonstrated the efficacy of PRP in various clinical settings, particularly in managing chronic tendinopathies, ligament injuries, and osteoarthritis. However, variability in PRP preparation techniques, application protocols, and patient outcomes has raised questions regarding its standardization and effectiveness [5,6]. Furthermore, while PRP therapy is considered safe and minimally invasive, the evidence regarding its long-term benefits and comparative efficacy with conventional treatments remains limited [7].

This study aims to evaluate the role of PRP therapy in promoting tissue regeneration and healing in musculoskeletal injuries. By analysing pain reduction and functional improvement, this research seeks to contribute to the growing body of evidence supporting the clinical utility of PRP in orthopaedic and sports medicine.

MATERIALS AND METHODS

This prospective study was conducted over a period of 12 months to evaluate the efficacy of Platelet-Rich Plasma (PRP) therapy in managing musculoskeletal injuries. The study included 50 patients aged 20 to 50 years who presented with musculoskeletal conditions such as tendon injuries, ligament tears, or muscle strains. Patients with systemic conditions like coagulopathies, infections at the injection site, or autoimmune diseases were excluded.

Preparation of PRP: PRP was prepared using a two-step centrifugation method. Initially, 20 mL of venous blood was drawn from each patient and placed in anticoagulant-coated tubes. The blood was subjected to a first centrifugation at 2000 rpm for 10 minutes to separate the plasma from red blood cells. A second centrifugation at 4000 rpm for 10 minutes was then performed to concentrate the platelets. The resultant PRP contained a platelet concentration approximately five times higher than baseline levels.

Intervention Protocol: Under aseptic conditions, the PRP was injected at the site of injury under ultrasound guidance to ensure accurate placement. A single injection was administered, and patients were advised to follow a standard rehabilitation protocol, including rest, gradual reintroduction of activity, and physical therapy as needed.

Outcome Measures: Outcomes were assessed using the Visual Analog Scale (VAS) for pain and the Musculoskeletal Function Scale (MFS) to evaluate functional improvement. Baseline data were recorded prior to the intervention, with follow-up assessments conducted at 4 weeks and 12 weeks post-treatment.

Statistical Analysis: Data were analysed using SPSS software version 25.0. Descriptive statistics were used to summarize patient demographics and clinical characteristics. Paired t-tests were conducted to compare baseline and post-treatment VAS and MFS scores. A p-value of <0.05 was considered statistically significant.

RESULTS

The study enrolled 50 patients, including 30 males and 20 females, with an average age of 35 ± 8 years. The most common injuries treated were tendon injuries (40%), followed by ligament tears (35%) and muscle strains (25%). All patients completed the follow-up assessments without significant adverse effects.

Pain Reduction (VAS Scores): The Visual Analog Scale (VAS) scores showed a significant reduction in pain levels following PRP therapy. At baseline, the mean VAS score was 7.5 ± 1.2, which decreased to 3.4 ± 1.0 at 4 weeks and further to 1.9 ± 0.7 at 12 weeks ($p < 0.05$). The greatest improvement was observed in patients with tendon injuries (Table 1)

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Table 1: Pain Reduction Measured by VAS Scores

Time point	Mean VAS Score (± SD)	p-value (Baseline vs. Time point)
Baseline	7.5 ± 1.2	-
4 weeks	3.4 ± 1.0	< 0.05
12 weeks	1.9 ± 0.7	< 0.05

Functional Improvement (MFS Scores): The Musculoskeletal Function Scale (MFS) scores also demonstrated significant improvement. The mean MFS score increased from 38.5 ± 6.2 at baseline to 65.3 ± 5.7 at 4 weeks and 78.9 ± 4.3 at 12 weeks ($p < 0.05$). Patients with ligament tears showed slightly slower improvement compared to those with tendon and muscle injuries (Table 2).

Table 2: Functional Improvement Measured by MFS Scores

Time point	Mean MFS Score (± SD)	p-value (Baseline vs. Time point)
Baseline	38.5 ± 6.2	-
4 weeks	65.3 ± 5.7	< 0.05
12 weeks	78.9 ± 4.3	< 0.05

Safety and Tolerability: No significant adverse events were reported during the study. Mild discomfort at the injection site was observed in 10% of patients, which resolved within 48 hours.

These findings suggest that PRP therapy is effective in reducing pain and improving function in patients with musculoskeletal injuries, with

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statistically significant results observed across all parameters.

DISCUSSION

The findings of this study demonstrate that Platelet-Rich Plasma (PRP) therapy significantly reduces pain and improves functional outcomes in patients with musculoskeletal injuries. These results align with previous research suggesting the efficacy of PRP in promoting tissue repair and regeneration through its high concentration of growth factors and bioactive molecules (1,2).

The significant reduction in Visual Analog Scale (VAS) scores observed in this study indicates PRP's potent analgesic effects, likely attributable to its ability to modulate inflammation and promote the repair of damaged tissues (3). Similar results have been reported by Mishra et al., who observed a marked improvement in pain scores in patients with chronic tendinopathies treated with PRP (4). The observed functional improvements, as evidenced by increased Musculoskeletal Function Scale (MFS) scores, further support the regenerative potential of PRP, which enhances cellular proliferation, angiogenesis, and extracellular matrix remodelling (5).

Interestingly, the greatest improvement in both pain and function was noted in patients with tendon injuries compared to ligament tears and muscle strains. This finding is consistent with studies that highlight PRP's superior efficacy in conditions where microvascular supply and growth factor responsiveness are critical (6). However, the slightly slower recovery in patients with ligament injuries may reflect the relatively avascular nature of these tissues, which can hinder the diffusion and bioavailability of PRP-derived growth factors (7).

The absence of significant adverse events in this study reinforces the safety profile of PRP therapy, as noted in other investigations (8). However, variability in patient response highlights the need for individualized treatment protocols. Factors such as injury type, chronicity, and patient-specific characteristics may influence therapeutic outcomes, underscoring the importance of further research to optimize PRP preparation and administration techniques (9).

Despite these promising results, several limitations warrant consideration. First, the sample size was relatively small, limiting the generalizability of the findings. Second, the follow-up period was limited to 12 weeks, which may not capture the long-term benefits or potential drawbacks of PRP therapy. Lastly, the lack of a control group in this study precludes direct comparison with other treatment modalities. Future studies should address these limitations by incorporating larger sample sizes, longer follow-up durations, and randomized controlled trial designs.

CONCLUSION

In conclusion, PRP therapy represents a safe and effective treatment modality for musculoskeletal injuries, with significant improvements in pain and functional outcomes. However, further high-quality research is necessary to establish standardized protocols and confirm its long-term efficacy.

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