Review Article

Efficacy of Platelet-Rich-Plasma in Accelerating Muscle Injury Recovery in Athletes: A Literature Review

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ABSTRACT

Muscle strains are the most common injury, leading to enormous amounts of time lost for training and participation in competitions, with long recovery periods and compromising the season play, especially when seniors are involved. The treatment of muscle injuries includes the traditional use of rest and ice compressions, but also involves the addition of physical therapy to improve the patient's condition and to help the rehabilitation of the acquired trauma. These injuries occur when muscle fibers are overstretched or torn, resulting in pain, swelling, and limited movement, which can impact both individual performance and overall team success. As a response to the limitations of conventional therapies, platelet-rich plasma (PRP) therapy has emerged as a promising treatment option, involving the injection of a concentrated solution of platelets derived from the patient's own blood into the injured area, in order to promote tissue healing and regeneration. While some studies suggest that PRP injections can lead to faster recovery times compared to traditional treatments, others indicate no significant benefits. This highlights the variability in outcomes influenced by factors such as injury type and PRP preparation methods. This literature review critically examines the current evidence regarding the efficacy of PRP injections in reducing recovery time for muscle injuries in athletes, aiming to provide a comprehensive understanding of its potential benefits and limitations, and to explore the hypothesis of whether PRP injections can effectively accelerate recovery for athletes with muscle strains and sports injuries.

Keywords: Platelet-Rich-Plasma (PRP); Muscle Strains; Sports; Injections

INTRODUCTION

Muscle strains represent a significant challenge in athletics, accounting for a substantial proportion of all sports-related injuries. The incidence rate of muscle strains ranges from 10-55% across various sports, highlighting the prevalent nature of this injury type. These injuries occur when muscle fibers are overstretched or torn, leading to pain, swelling, and limited movement. The impact of muscle injuries on athletes and sports teams is substantial, affecting individual performance, team dynamics, and overall success in competitions (2).

In 16 major international athletics championships, muscle injuries were the most common injury type, constituting 41% of total injuries. For example, in soccer, muscle injuries account for approximately 31% of all injuries, with a male professional-level soccer team of

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25 players expecting about 15 muscle injuries each season. This results in an average of 223 days of absence, 148 missed training sessions, and 37 missed games. Additionally, muscle injuries account for an estimated 15% of track injuries, 18% of basketball injuries, and 46% of injuries in American football, with 22% occurring during games. Hamstring injuries alone result in an average hiatus of 90 days and 15 missed matches per club per season in elite soccer (6).

The recovery time for muscle strains can vary widely, from a few days to several months, depending on the severity of the injury and the individual's healing capacity. On average, recovery usually takes 2-3 weeks, causing athletes to lose crucial training and competition time. Traditional treatments for muscle strains include conservative measures including, rest, ice, compression, along with physical therapy and anti-inflammatory medications. However, the prolonged variation in recovery times has led physicians to explore novel and potentially faster-acting treatments (7).

Platelet-rich plasma (PRP) therapy has emerged as a promising treatment for sports-related muscle strains and injuries. PRP therapy involves injecting a concentrated solution of platelets from the patient's own blood into the injured area. Platelets contain a significant amount of growth factors that are believed to help promote tissue healing and regeneration. In various medical fields including orthopedics, dermatology, and dentistry, PRP has demonstrated to be widely efficacious, strengthening the rationale for its application in treating sports-related injuries. For instance, PRP has been effectively used to treat chronic tendinopathies and accelerate bone healing in common dental procedures (8, 9).

Despite growing interest in PRP therapy, its effectiveness in reducing recovery time for muscle injuries in athletes remains uncertain. While some studies report positive outcomes, others find no significant differences from traditional approaches. Additionally, PRP injections, while generally considered low-risk, do carry some potential adverse effects that athletes should be aware of. One significant risk is infection, which can occur if the injection site is not properly disinfected. Similarly, nerve or tendon injuries as well as bruising and inflammation can occur secondary to improper needle placement. Overall, while serious complications are rare, it is essential for athletes to discuss these risks with their healthcare provider to ensure informed decision-making regarding PRP therapy. Overall, this inconsistency has led to ongoing efforts and clinical trials to better understand the potential benefits and limitations of PRP therapy in sports medicine (10).

This literature review aims to critically examine current evidence regarding the efficacy of PRP injections in reducing recovery time for muscle-related injuries. By analyzing available research, this review also aims to provide a comprehensive understanding of the respective benefits and limitations of PRP therapy in sports medicine. Specifically, the hypothesis: "Do PRP injections accelerate recovery time for athletes with muscle strains and sports injuries?" will be explored.

METHODS

My exploration of platelet-rich plasma (PRP) therapy was motivated by an interest in its application for muscle strain injuries in athletes. A review of the existing literature revealed a lack of studies specifically addressing this topic, particularly concerning muscle injuries sustained during athletic activities. This limited body of research highlights the need for further investigation into the effectiveness of PRP therapy in this context.

The methodologies employed in the studies varied significantly. While many investigations involved human participants who experienced accidental injuries, some studies utilized animal models, intentionally inducing muscle injuries to assess the effects of PRP treatment. This diversity in experimental design reflects the challenges researchers face in establishing a consistent understanding of PRP's therapeutic potential for muscle injuries.

In selecting studies for my literature review, I focused on those that specifically examined muscle injuries resulting from sports-related activities. I prioritized credible sources, including PubMed and the American Journal of Sports Medicine, ensuring that each selected study featured a substantial sample size and credible results. This careful selection process was essential to enhance the credibility of the findings presented in my review, ultimately contributing to a more comprehensive understanding of PRP therapy's role in athletic recovery.

In most clinical studies, PRP is prepared from the athlete's own blood, which is then centrifuged to concentrate the platelets. Injections are typically administered within a few days of the injury occurrence. Follow-up assessments are conducted at regular intervals to track recovery progress, with the primary outcome usually being either time to return to play or full recovery. Varied approaches, including animal models, human clinical trials, and meta-analyses are reviewed in this paper, providing a comprehensive view of PRP's effects in athletic populations.

Key Studies

Study One: This study was conducted in a controlled laboratory setting using rat models. The rats were injured by either a single (large strain) or multiple (small strain) lengthening contractions. The tibialis anterior muscle was subjected to one of three protocols: PRP injections, platelet-poor plasma (PPP) as a control, or no intervention. Muscle contraction torque (measurement of the rotational force generated by dorsiflexor muscles of the rats) was measured as the primary outcome (1).

Study Two: A randomized controlled trial in a clinical setting with human athletes was performed, evaluating the efficacy of autologous PRP injection for acute hamstring injuries. The study involved 28 athletes with confirmed acute hamstring injuries (grade 2a based on the Functional Assessment Scale). Participants were randomly assigned to PRP (n=14) or the control group (n=14), where the PRP group received a single PRP injection under ultrasound guidance followed by a structured rehabilitation program. Meanwhile, the control group underwent the same rehabilitation program without PRP. The primary outcome was the time to return to play, with additional assessments of pain severity using the Brief Pain Inventory - Short Form (BPI-SF) (5).

Study Three: This study was a systematic review and meta-analysis which included six randomized controlled trials (RCTs) involving a total of 374 patients with acute muscle injuries. The studies compared PRP injections to placebo injections or physical therapy. Inclusion criteria required patients to have acute (≤7 days) grade I or II muscle strains confirmed by clinical examination and/or imaging. Exclusion criteria included case series, review articles, technique descriptions, basic science articles lacking patient-specific data, and studies with less than six months of follow-up for reinjury rates. Outcomes evaluated included time to return to sport, reinjury rates, complications, pain levels, muscle strength, range of motion, muscle function, and imaging results (3).

These methodologies aim to provide a thorough assessment of PRP's efficacy in treating acute muscle injuries, drawing from a diverse range of study designs and populations to offer comprehensive insights into this emerging therapy in sports medicine.

RESULTS

In the first study, researchers induced injury in rat models to study the recovery of function in the whole ankle dorsiflexor group, focusing on the tibialis anterior (TA) muscles, which generate most of the torque in this group. The peak isometric torque for each animal was measured before injury (set as 100%; mean ± SD torque: 44 ± 5 Nmm). Two injury protocols resulted in significant muscle function loss, followed by gradual recovery. In the multiple repetition protocol, PRP treatment led to a marked improvement in contractile function at days 7 and 14, effectively reducing the time for full recovery from 21 days to 14 days (Figure 1) (1).

Maximal torque was measured in each animal before and immediately after injury, as well as at selected time points post-injury. After a single repetition through a 90-degree arc of motion, a significant drop in torque was observed, followed by gradual recovery to full function by day 7. For multiple repetitions through a 60-degree arc of motion, PRP significantly impacted days 7 and 14, with the injured muscle returning to pre-injury strength. This study demonstrated that PRP could reduce recovery time

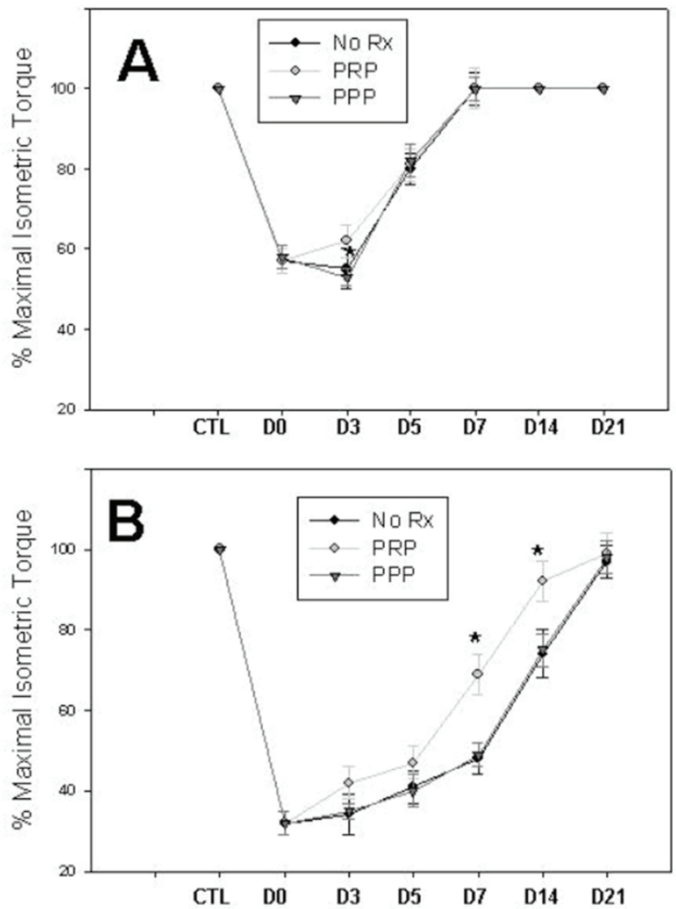

Figure 1. Maximal torque was measured in each animal before injury (CTL) and immediately after injury (D0). Adapted from Hammond et al. [2009].

by 7 to 14 days (Figure 1) (1).

The second study involved a randomized controlled trial (RCT) with 28 patients suffering from sports-related muscle injuries, divided into a control group and a PRP group. A survival curve illustrated the effect over time for patients in both intervention groups (Figure 2) (5).

This study aimed to evaluate the effectiveness of PRP injections in reducing recovery time for sports-related muscle injuries. It was found that 50% of patients receiving PRP treatment achieved complete recovery by week 26 of the follow-up period, compared to the control group, which reached the same recovery rate at week 29. The average time for athletes to return to play was significantly shorter in the PRP group (26.7 ± 7.0 days) compared to the control group (42.5 ± 20.6 days). Statistical analysis using the log-rank (Mantel-Cox) test demonstrated a significant difference in recovery patterns between the two groups, further supporting the effectiveness of PRP treatment in accelerating muscle injury recovery (5).

The third study, a systematic review and meta-analysis involving 374 participants across six eligible studies, aimed to compare the time to return to sport and reinjury rates following PRP injection versus control therapy in patients with acute grade I or II muscle strains. Results indicated a significant reduction in time to return to sport in the PRP group compared to the control group (placebo or rehabilitation), with a mean difference (MD) of -5.57 days (95% CI -9.57 to -1.58; P=0.006). However, a subgroup analysis focusing solely on acute grade I or II hamstring muscle strains found no significant difference in time to return to sport between the PRP and control groups (3 studies, 159 patients; MD -3.92 days [95% CI -9.73 to 1.89]; P=0.19) (3).

Further analysis of studies with higher methodological quality also found no significant difference in time to return to sport between PRP and control therapy (4 studies, 234 patients; MD -3.28 days [95% CI -6.61 to 0.05]; P=0.05). Additionally, no difference was observed in return to sport between PRP and control therapy in studies that included only acute grade II muscle strains (2 studies, 99 patients; MD 8.21 days [95% CI -19.42 to 3.00]; P=0.15) (3). The meta-analysis suggests that PRP injections can significantly reduce the time to return to sport for patients with grade I or II muscle strains without increasing the risk of reinjury at six months follow-up. However, subsequent subgroup analyses did not show this benefit for patients with hamstring strains. For most sports, an earlier return to play by approximately one week could enable an athlete to participate in 1 to 2 additional games, potentially having a significant clinical impact (3).

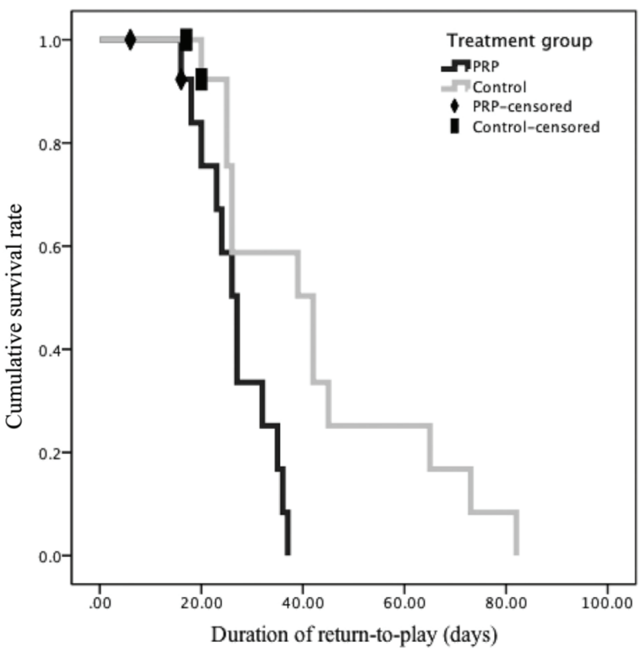

Figure 2. Survival functions of the control and platelet-rich plasma groups. Adapted from Hamid et al. [2014].

DISCUSSION

The variability in results across these studies highlights the complexity of PRP therapy. While the first two studies—encompassing both an animal model and clinical trial—suggest significant benefits, the meta-analysis points to inconsistencies, particularly within subgroups with specific types of muscle strains such as hamstring injuries. These findings suggest that while PRP therapy may be effective in some cases, its outcomes could be influenced by factors such as the type of injury, PRP preparation protocols, and individual patient characteristics. These discrepancies underscore the necessity for further research to confirm PRP's benefits and optimize treatment protocols. More randomized controlled trials would be especially valuable, as they are less likely to be influenced by external factors.

The first study focused on a controlled laboratory setting with rat models. This study was strengthened by several methodological advantages. One key benefit was the use of two distinct in vivo protocols to induce muscle injury: a 90° arc of plantarflexion for acute strains and a 60° arc for repeated strains. This dual approach enabled a comprehensive analysis of PRP's effectiveness across different types of muscle injuries. The controlled environment of an animal model allowed for precise control over variables such as contraction force, type, and timing, as well as dietary and activity levels. This level of control helped ensure the internal validity of the study by minimizing external variables that could affect the results. Furthermore, the study's use of maximal stimulation to recruit all motor units within the muscle ensured consistent injury induction, facilitating reliable comparisons of recovery outcomes (1).

However, the use of an animal model also has its limitations. The applicability of animal model results to human conditions remains uncertain, as the controlled experimental parameters do not fully represent the complexity and variability of human muscle injuries. Additionally, the study did not identify which specific components of PRP were responsible for the observed improvements in muscle recovery, leaving questions about the optimal formulation and dosage. These gaps highlight the need for further research to determine the most effective use of PRP in treating muscle injuries, including the appropriate type of strain injury, optimal dose, and delivery method, as well as if animal models would provide accurate representation (1).

In the second study, the use of platelet-rich plasma (PRP) injections for accelerating recovery in athletes with muscle strains has been increasingly researched, with this study offering several key advantages in its approach. Firstly, it represents one of the first RCTs specifically assessing PRP's effectiveness for hamstring injuries, providing a higher level of evidence than previous case reports or retrospective studies. The study's design, focusing on grade 2a hamstring injuries, offers valuable insights into a common and specific clinical problem, potentially guiding future treatment protocols for this particular injury type (5).

Moreover, the study's methodology includes several strengths that enhance its reliability and applicability. The use of ultrasound-guided injections makes sure of accurate PRP delivery to the injured area, improving the consistency of treatment. The comprehensive assessment criteria, combining both subjective pain measures (BPI-SF) and objective physical and strength assessments (Biodex isokinetic machines), provide a robust evaluation of recovery. Additionally, the study's comparison of PRP-treated patients with a control group without the use of concurrent medications allows for a clearer evaluation of PRP's specific effects. These methodological advantages contribute to a more rigorous assessment of PRP's efficacy in treating muscle strains, offering a solid foundation for future research in this area (5).

Despite these strengths, several limitations exist in this study. Variability in PRP preparation methods, injection techniques, and rehabilitation protocols across studies complicates comparisons and may affect outcomes. Additionally, most patients did not record their daily unsupervised rehabilitation sessions at home, potentially leading to varied results, although they confirmed adherence during follow-up appointments (5).

The third study, involving 268 patients across five investigations, presents several notable advantages regarding the use of PRP injections for muscle strain recovery. This systematic review, which included five randomized trials, most of which exhibited moderate to excellent methodological quality, provides a comprehensive analysis of the available evidence. By employing an extensive search strategy across various electronic databases, the researchers ensured that all relevant studies were considered, significantly enhancing the credibility of their findings. Additionally, the study addressed heterogeneity in rehabilitation protocols and PRP characteristics—such as frequency, volume, and manufacturer—crucial factors for understanding the diverse outcomes observed in PRP research. By acknowledging these differences, the study sets the stage for future research to determine the optimal PRP composition and application methods for muscle injuries (3).

Nonetheless, this systematic review also had limitations. Despite finding a statistically and clinically significant difference in time to return to sport favoring PRP, there was substantial heterogeneity among the eligible studies. Specifically, heterogeneity in outcome measures prevented further pooled subgroup analyses, making it difficult to draw definitive conclusions about the effect of PRP on other patient-reported and physician-derived outcomes such as pain, satisfaction, and strength (3).

CONCLUSION

The examination of platelet-rich plasma (PRP) therapy for muscle injuries reveals a complex interplay of efficacy, methodology, and variability across studies. While initial findings indicate that PRP can significantly enhance recovery, particularly in controlled settings, the differences noted in larger meta-analyses highlight the need for further investigation. The strengths of the reviewed studies, such as rigorous methodologies and comprehensive assessment protocols, provide valuable insights into PRP's potential benefits. However, limitations including variability in PRP preparation, injection techniques, and the applicability of animal models to human conditions raise critical questions about the generalizability of these findings.

Future research should focus on addressing these gaps by standardizing PRP preparation methods, exploring the specific components responsible for recovery, and conducting larger randomized controlled trials that include diverse patient populations and injury types. Additionally, investigating optimal dosages and delivery methods could refine treatment protocols and enhance clinical outcomes. By systematically addressing these areas, the scientific community can improve the understanding of PRP therapy, ultimately leading to more effective and tailored interventions for individuals suffering from muscle strains. All in all, while there is a strong promise for PRP therapy, further and larger studies are required to solidify the role of PRP injections in every day clinical practices.

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DECLARATION OF CONFLICT OF INTERESTS

The author(s) declare that there are no conflicts of interest regarding the publication of this article.

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