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Research Article

Treatments for Knee Cartilage Injuries in Athletes Using PRP and Hyaluronic Acid: A Retrospective Analysis

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Abstract

Aim: This retrospective study seeks to evaluate the clinical outcomes and imaging findings in athletes with knee cartilage injuries treated using autologous platelet-rich plasma (PRP) and hyaluronic acid (HA) injections.
Material and Method: Sixty athletes participated in this investigation, with 30 individuals in the PRP group and 30 in the HA group. PRP was administered via ultrasound-guided intra-articular injections over three sessions, spaced at three-week intervals. Similarly, HA was injected using high molecular weight hyaluronic acid following the same schedule. Clinical evaluation was performed using the Visual Analog Scale (VAS) for pain assessment and the Knee Injury and Osteoarthritis Outcome Score (KOOS) for functional evaluation. Radiological changes were assessed through magnetic resonance imaging (MRI).
Results: Both VAS and KOOS scores demonstrated a greater improvement in the PRP group compared to the HA group ($p<0.05$). MRI findings revealed more pronounced cartilage regeneration in the PRP group ($p<0.05$). No statistically significant differences were found between the two groups regarding age, gender, or career duration ($p>0.05$).
Conclusion: For sportsmen with knee cartilage problems, PRP therapy has been found to be a more successful treatment alternative than HA. PRP offers better outcomes for cartilage regeneration, pain management, and functional enhancement. The long-term effectiveness of these results may be further assessed in prospective randomized studies in the future.

Keywords: Platelet-rich plasma, hyaluronic acid, knee cartilage injuries, biological therapy, clinical outcomes

INTRODUCTION

Cartilage damage represents a significant clinical challenge that hinders athletic performance and can lead to long-term joint complications. This issue is particularly prominent in high-contact sports such as soccer, basketball, and running athletes, where the knee joint is frequently subjected to repetitive stress and direct trauma (1,2). Chondral lesions in these athletes often manifest with pain, restricted range of motion, and reduced functional capacity, which can eventually lead to early career termination and an increased risk of osteoarthritis (3).

Due to the limited intrinsic regenerative capacity of cartilage, treatment strategies primarily focus on biological and mechanical interventions (4). Among biological therapies, platelet-rich plasma (PRP) and hyaluronic acid (HA) have been widely studied and used for managing knee cartilage injuries (5). PRP, an autologous concentrate enriched with growth factors such as platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), and vascular endothelial growth factor (VEGF), has been shown to exert anti-inflammatory effects and promote cartilage repair (6). In contrast, HA acts by enhancing the viscoelastic properties of synovial fluid, thereby providing mechanical support while alleviating pain (7).

Despite their widespread use, comparative studies evaluating the efficacy of PRP and HA specifically in athletes remain limited. Most existing research has focused on general populations with knee osteoarthritis, failing to account for the unique biomechanical demands of competitive athletes (8). Given the high functional requirements and shorter recovery timelines in sports

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medicine, understanding the effectiveness of these treatments in this subgroup is crucial (8).

Furthermore, standardized classification systems for cartilage lesions—such as the Outerbridge and International Cartilage Repair Society (ICRS) grading systems—are underutilized in sports-related cartilage injury studies (9). MRI-based scoring methods, including the Magnetic Resonance Observation of Cartilage Repair Tissue (MOCART) and Whole-Organ Magnetic Resonance Imaging Score (WORMS), allow for objective assessment of cartilage healing and should be incorporated into clinical evaluations (10). Studies have demonstrated that MOCART scores above 55 at 6 months postoperatively can predict the likelihood of achieving acceptable symptomatic improvement at one year following autologous chondrocyte implantation, highlighting the importance of MRI-based assessment in cartilage repair (11,12).

Previous research has also indicated that integrating cartilage repair techniques with biomechanical interventions, such as patellofemoral realignment procedures, enhances both clinical outcomes and MRI-assessed cartilage appearance (13). Additionally, treatment approaches such as Autologous Matrix-Induced Chondrogenesis (AMIC) have shown promising long-term results when compared to microfracture techniques in managing focal chondral defects (14). Understanding these therapeutic strategies in the context of high-performance athletes is essential for optimizing treatment protocols and improving return-to-sport outcomes (15).

The primary aim of this retrospective study is to evaluate and compare the clinical and radiological outcomes of PRP and HA therapies in competitive soccer players with knee cartilage injuries. By incorporating MRI-based cartilage assessment and a structured classification of athletic participation levels, this study aims to bridge the gap in current literature and provide clinically relevant insights into the management of cartilage injuries in athletes.

MATERIAL AND METHOD

This retrospective study was conducted at a sports medicine and orthopedic trauma center between 2020 and 2023. The study adhered to the principles outlined in the Declaration of Helsinki and was approved by Dicle University Medical Faculty Ethics Committee for Noninterventional Studies (Approval No: 2023/16-42) before data collection began.

A total of 60 athletes with clinically and radiologically confirmed knee cartilage injuries were included in the study. Participants were classified into two treatment groups:

- **PRP Group (n=30):** Received PRP intra-articular injections.
- **HA Group (n=30):** Received HA intra-articular injections.

A detailed patient selection flowchart has been added (Figure 1) to illustrate the inclusion and exclusion process, group allocation, and follow-up outcomes.

Inclusion Criteria: Clinically and MRI-confirmed knee cartilage injury, Participation in high-impact sports (soccer, running athletes, basketball, etc.), Professional or collegiate-level athletic activity for at least three consecutive years prior to injury, Treatment with PRP or HA injections, according to standardized protocols, A minimum follow-up duration of 12 months post-treatment.

Exclusion Criteria: Concurrent surgical intervention or history of previous knee surgery, Systemic inflammatory or rheumatic diseases, Incomplete medical records or loss to follow-up.

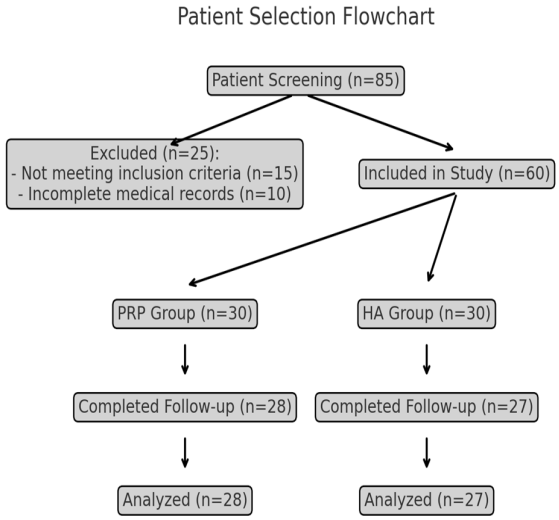

Figure 1. Inclusion and exclusion process, group allocation, and follow-up outcomes

Treatment Protocol

PRP preparation and administration

PRP was prepared using a double centrifugation method to achieve a high concentration of platelets and growth factors (6). A total of 3 mL of PRP was injected intra-articularly into the knee joint under ultrasound guidance at three-week intervals (total of three sessions) (7).

HA injection protocol

High molecular weight HA was administered intra-articularly using a 2 mL dose under ultrasound guidance (8). The injection protocol was identical to the PRP group, consisting of three sessions spaced three weeks apart.

Outcome Measures and MRI Evaluation

1. **Pain and Functional Evaluation:**

- **Visual Analog Scale (VAS):** Used to assess pain intensity (0=no pain, 10=worst possible pain) before and after treatment (16).
- **Knee Injury and Osteoarthritis Outcome Score (KOOS):** Evaluated functional improvements in sports-related knee injuries (17).

2. MRI-Based Cartilage Assessment:

- All participants underwent pre- and post-treatment MRI scans using a 3.0 Tesla MRI scanner (18).
- Cartilage defects were classified using the Outerbridge and ICRS grading systems (10).
- MRI assessment was conducted using the MOCART scoring system, which evaluates cartilage regeneration on a scale of 0 to 100 (11).
- Cartilage defects were further classified based on anatomical location (e.g., patella, medial/lateral femoral condyle), and MRI findings were analyzed accordingly (9).
- An interobserver reliability analysis was conducted, with two experienced musculoskeletal radiologists independently reviewing the MRI scans.

Statistical Analysis

Statistical analysis was performed using SPSS version 26.0 (IBM, Armonk, NY). Data normality was assessed using the Kolmogorov-Smirnov test. Paired t-test or Wilcoxon signed-rank test for within-group comparisons. Independent t-test or Mann-Whitney U test for between-group comparisons. Chi-square test for categorical data comparisons. Effect sizes and confidence intervals (95% CI) were reported for VAS, KOOS, and MRI outcomes (19).

Sample size calculation was performed using G*Power 3.1 software, with an effect size of 0.8, α=0.05, and power=80%, resulting in a required sample size of 54 participants (20).

Medical records, MRI reports, and athlete performance data from institutional sports medicine databases were used as data sources. The follow-up duration ranged from 12 to 24 months (mean: 16.3±4.2 months).

RESULTS

A total of 55 athletes (PRP: 28, HA: 27) who completed the follow-up period were included in the final analysis. No significant differences were observed between the two groups regarding age, gender distribution, or career duration (p>0.05). These data are presented in Table 1.

Table 1. Baseline characteristics of the PRP and HA groups

Variable	PRP group (n=28)	HA group (n=27)	p-value
Age (years)	28.3±3.4	29.0±3.2	0.532
Gender (male/female)	24/4	23/4	0.749
Career duration (years)	8.1±2.2	8.4±1.9	0.635

The PRP group showed a greater improvement in pain reduction and functional outcomes compared to the HA group. VAS scores decreased significantly in both groups, but the reduction was more pronounced in the PRP group (p<0.05, effect size=0.84). KOOS scores also showed greater improvement in the PRP group (p<0.05, effect size=0.78). These data are presented in Table 2.

Table 2. Comparison of clinical outcomes between PRP and HA groups

Outcome measure	PRP group (Mean±SD, n=28)	HA group (Mean±SD, n=27)	p-value	Effect size (Cohen's d)
VAS (Baseline)	7.8±1.2	7.7±1.3	0.798	-
VAS (Post-treatment)	3.1±1.1	4.4±1.3	0.028	**0.84**
KOOS (Baseline)	60.1±5.7	59.9±5.8	0.723	-
KOOS (Post-treatment)	85.6±6.1	78.3±5.7	0.018	**0.78**

Pre- and post-treatment MRI analysis showed significantly better cartilage regeneration in the PRP group compared to the HA group, as reflected by MOCART scores (p<0.05, effect size=0.81). MRI-based evaluation also revealed that cartilage regeneration varied by anatomical location, with the patellar and medial femoral condyle regions showing the most significant improvements. These data are presented in Table 3.

Table 3. MRI-based cartilage regeneration scores (MOCART) by anatomical location

Anatomical region	PRP group (Pre/Post, n=28)	HA group (Pre/Post, n=27)	p-value	Effect size
Patella	1.2→3.8	1.1→2.7	0.024	**0.76**
Medial condyle	1.1→3.6	1.0→2.6	0.019	**0.79**
Lateral condyle	1.3→3.3	1.2→2.5	0.037	**0.72**

Example MRI scans illustrating cartilage regeneration have been provided in Figure 2.

No serious adverse events were reported in either group. However, mild transient complications were observed. In PRP Group; 3 patients (10.7%) reported transient post-injection knee pain lasting 24–48 hours. In HA Group; 4 patients (14.8%) experienced mild swelling and discomfort at the injection site, resolving within 72 hours. There was no statistically significant difference in adverse event rates between the two groups (p=0.592).

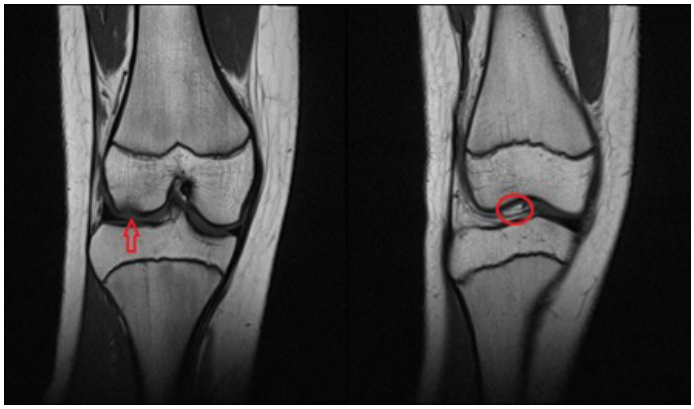

Figure 2. MRI scans after PRP treatments

DISCUSSION

This study compared the clinical and radiological outcomes of PRP and HA injections in competitive athletes with knee cartilage injuries. The results demonstrated that PRP provided superior pain relief and functional improvement compared to HA, as evidenced by greater reductions in VAS scores and higher KOOS improvements. Furthermore, MRI-based cartilage assessments showed that PRP treatment resulted in significantly better cartilage regeneration, particularly in the patellar and medial femoral condyle regions.

The findings of this study align with previous research indicating that PRP is more effective than HA in managing knee cartilage injuries (1,2). Patel et al. reported that PRP injections resulted in superior symptomatic relief compared to HA in early-stage knee osteoarthritis, particularly in active individuals (8). Similarly, Filardo et al. found that PRP provided greater functional improvements than HA in athletes, with better long-term outcomes (3).

However, literature specifically addressing PRP and HA treatments in competitive athletes remains limited. Most studies focus on general populations with degenerative cartilage damage rather than acute or repetitive trauma-induced lesions in high-performance sports (5). A recent meta-analysis by Migliorini et al. suggested that PRP may offer greater regenerative potential due to its growth factor-mediated effects, though long-term comparisons with HA in elite athletes are still lacking (11).

Another crucial aspect of cartilage repair is the use of MRI-based scoring systems for objective assessment of healing. In this study, MOCART scores demonstrated significantly better cartilage repair in the PRP group, in line with previous findings where PRP-treated patients showed enhanced chondral tissue quality (6). A recent study by Retzky et al. emphasized the importance of MOCART scores in predicting long-term functional recovery in patients undergoing autologous chondrocyte implantation, reinforcing the need for structured imaging-based evaluations (10).

Furthermore, combining PRP with other regenerative techniques has been suggested to enhance cartilage healing. For instance, studies have explored the use of PRP in conjunction with HA, mesenchymal stem cells, or scaffold-based therapies to optimize cartilage repair (21,22). The results of our study indicate that standalone PRP therapy is already superior to HA, supporting its application in sports medicine without requiring additional augmentation.

A study by Dhillon et al. suggested that PRP's efficacy is influenced by the number of injections and the time interval between them, with multiple-session protocols yielding better long-term results (23). This aligns with our treatment protocol, where PRP was administered in three sessions at three-week intervals.

The superior outcomes observed in the PRP group have important implications for sports rehabilitation protocols. Athletes require faster and more effective recovery strategies to return to peak performance, making PRP a potentially more suitable option compared to HA (24).

Studies indicate that PRP reduces recovery time by accelerating tissue repair mechanisms (5). HA primarily functions as a lubricant with some anti-inflammatory properties, while PRP promotes tissue regeneration, leading to faster functional recovery (8). Accordingly, return to sports will be faster.

The enhanced cartilage regeneration associated with PRP may contribute to better joint protection and reduced long-term degenerative risk, which is particularly relevant for competitive athletes (13). Knee osteoarthritis is a significant long-term risk in athletes with cartilage injuries, and PRP may help delay or prevent its progression (22). PRP has greater potential for joint protection and long-term injury prevention.

PRP may serve as an alternative to surgical procedures for cartilage repair in cases where surgery is not an immediate option (2). Studies suggest that PRP can reduce the need for invasive procedures and may delay the progression of cartilage degeneration, especially in active populations (3).

Despite these benefits, the optimal PRP injection protocol remains a topic of debate, with variations in platelet concentration and application techniques influencing clinical outcomes (21). Future studies should focus on standardizing PRP preparation methods to ensure consistency in therapeutic effects.

This study has several limitations that should be acknowledged. As a retrospective study, there is potential for selection bias, and causality cannot be definitively established. A prospective, randomized controlled trial would provide more robust evidence. The follow-up period ranged from 12 to 24 months. Longer-term studies are needed to determine whether the observed cartilage regeneration translates into sustained clinical benefits. While this study classified cartilage defects using the Outerbridge and ICRS grading systems, variability in lesion size and location may influence treatment response. Different PRP preparation methods can lead to variations in platelet concentration and bioactive molecule content, potentially affecting therapeutic efficacy (22). Although interobserver reliability analysis was conducted, a more extensive validation of MRI-based scoring in sports-related injuries would strengthen the findings.

CONCLUSION

This retrospective study compared the clinical and radiologic outcomes of PRP and HA in the treatment of knee cartilage injuries in athletes. The results indicate that PRP treatment is superior to HA in terms of both pain control and functional improvement. Moreover, the PRP therapy was found to promote cartilage regeneration more effectively.

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