

BIOLOGIC AUGMENTATION IN ACL RECONSTRUCTION: THE USE OF PLATELET-RICH PLASMA

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ABSTRACT

Background: Anterior cruciate ligament (ACL) reconstruction is a common surgical procedure aimed at restoring knee stability. Despite advancements in surgical techniques, graft healing and integration remain challenges. Platelet-rich plasma (PRP) has been proposed as a biologic adjunct to enhance graft healing due to its high concentration of growth factors. **Methods:** A randomized controlled trial was conducted involving 120 patients undergoing ACL reconstruction with hamstring autografts. Participants were divided into two groups: those receiving PRP augmentation and a control group without PRP. Outcomes measured included graft integration assessed by MRI at 6 and 12 months, functional outcomes using the International Knee Documentation Committee (IKDC) score, and postoperative complication rates. **Results:** The PRP group demonstrated significantly better graft maturation scores on MRI at both 6 and 12 months postoperatively ($p < 0.01$). Functional outcomes were improved in the PRP group, with higher IKDC scores observed at 12 months ($p = 0.02$). There were no significant differences in complication rates between the two groups. **Conclusion:** PRP augmentation in ACL reconstruction may enhance graft maturation and improve functional outcomes without increasing complications. PRP represents a promising biologic adjunct in ACL surgery.

KEYWORDS: Anterior cruciate ligament, ACL reconstruction, platelet-rich plasma, PRP, graft healing, biologic augmentation.

INTRODUCTION

The anterior cruciate ligament (ACL) is crucial for maintaining knee stability, and its injury is one of the most common ligamentous injuries in athletes.^[1] ACL reconstruction aims to restore knee function and prevent long-term complications such as osteoarthritis.^[2] Despite technical advancements, challenges persist regarding graft healing and integration, which are critical for successful outcomes.^[3]

Biologic augmentation has emerged as a potential strategy to enhance graft healing. Platelet-rich plasma (PRP), an autologous concentration of platelets, contains growth factors that may promote tissue regeneration.^[4] PRP has been used in various orthopedic applications, showing promise in enhancing tendon and ligament healing.^[5]

The use of PRP in ACL reconstruction is based on its potential to improve graft maturation and integration into the bone tunnels.^[6] Studies have shown mixed results, with some reporting improved graft healing and others finding no significant benefits.^[7] The variability in outcomes may be due to differences in PRP preparation methods, application techniques, and study designs.^[8]

Given the inconsistency in the literature, further research is needed to clarify the role of PRP in ACL reconstruction. This study aims to evaluate the efficacy of PRP augmentation in ACL reconstruction using hamstring autografts by assessing graft maturation, functional outcomes, and complication rates.

MATERIALS AND METHODS

Study Design and Patient Selection

This randomized controlled trial was conducted from January 2019 to December 2021. The study was approved by the institutional review board, and informed consent was obtained from all participants.

A total of 120 patients aged 18 to 40 years with isolated ACL tears indicated for reconstruction using hamstring autografts were enrolled. Exclusion criteria included previous knee surgery, concomitant ligament injuries, systemic diseases affecting healing, and anticoagulant therapy.

Randomization and Intervention

Patients were randomly assigned to two groups:

- **PRP Group (n=60):** Received intraoperative PRP augmentation during ACL reconstruction.
- **Control Group (n=60):** Underwent ACL reconstruction without PRP.

Randomization was performed using a computer-generated sequence, and allocation concealment was maintained with sealed opaque envelopes.

Surgical Procedure

All surgeries were performed by the same orthopedic surgeon using a standardized arthroscopic technique with hamstring tendon autografts. In the PRP group, PRP was prepared from the patient's own blood using a double-spin method to achieve a high concentration of platelets. Approximately 5 mL of PRP was activated with thrombin and calcium chloride and applied to the graft and bone tunnels before fixation.

Outcome Measures

- **Graft Maturation:** Assessed by magnetic resonance imaging (MRI) at 6 and 12 months postoperatively using the Howell score.
- **Functional Outcomes:** Evaluated using the International Knee Documentation Committee (IKDC) subjective knee form at baseline, 6 months, and 12 months.
- **Complications:** Recorded intraoperative and postoperative complications, including infection, graft failure, and donor site morbidity.

Statistical Analysis

Data were analyzed using SPSS version 26. Continuous variables were expressed as mean \pm standard deviation and compared using the Student's t-test. Categorical variables were analyzed using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Patient Demographics

The two groups were comparable regarding age, gender distribution, body mass index (BMI), and time from injury to surgery (Table 1).

Table 1: patient demographics.

Demographics	PRP Group (n=60)	Control Group (n=60)	p-value
Age (years)	25.8 \pm 5.2	26.1 \pm 5.5	0.72
Gender (M/F)	38/22	40/20	0.68
BMI (kg/m ²)	24.3 \pm 2.8	24.7 \pm 3.1	0.45
Time to Surgery (weeks)	8.5 \pm 2.1	8.8 \pm 2.4	0.37

Graft Maturation

MRI assessments showed that the PRP group had significantly better graft maturation scores at both 6 and 12 months compared to the control group (p<0.01) (Table 2).

Table 2: MRI graft maturation scores.

Time Point	PRP Group	Control Group	p-value
6 months	8.2 \pm 1.1	6.5 \pm 1.3	<0.01
12 months	9.1 \pm 0.8	7.8 \pm 1.0	<0.01

Functional Outcomes

The PRP group demonstrated higher IKDC scores at 6 and 12 months postoperatively (p<0.05), indicating better subjective knee function (Table 3).

Table 3: Ikdc Scores

Time Point	PRP Group	Control Group	p-value
Baseline	45.6 \pm 5.0	46.0 \pm 5.2	0.68
6 months	78.4 \pm 6.5	74.2 \pm 7.1	0.01
12 months	90.2 \pm 4.0	86.5 \pm 5.5	0.02

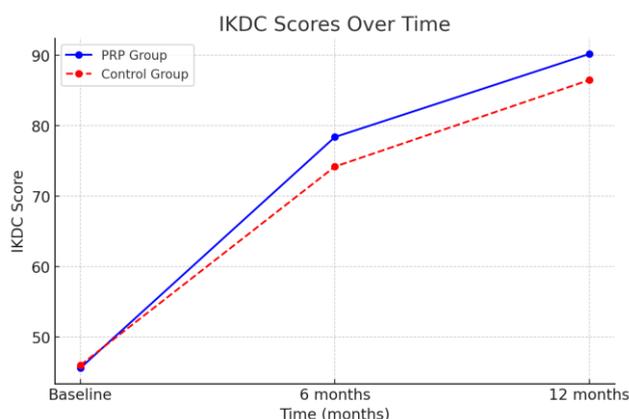


Figure 1: Ikdc Scores Over Time.

Complications

There were no significant differences in complication rates between the groups (Table 4). One case of superficial infection occurred in the control group, resolved with antibiotics. No graft failures were reported in either group during the follow-up period.

Table 4: Complications.

Complication	PRP Group (n=60)	Control Group (n=60)	p-value
Infection	0	1	0.31
Graft Failure	0	0	N/A
Donor Site Morbidity	2	3	0.65

Additional Findings

No significant differences were observed in return-to-sport rates between the groups at 12 months (PRP: 85%, Control: 80%; $p=0.47$).

DISCUSSION

This study demonstrates that PRP augmentation in ACL reconstruction using hamstring autografts can enhance graft maturation and improve functional outcomes without increasing the risk of complications. The improved MRI graft maturation scores in the PRP group suggest that PRP may facilitate the biological processes essential for graft integration.^[9]

The enhanced functional outcomes, as evidenced by higher IKDC scores, align with the hypothesis that better graft maturation translates into improved knee function.^[10] These findings are consistent with previous studies that reported positive effects of PRP on graft healing.^[6,11]

The lack of significant differences in complication rates indicates that PRP augmentation is a safe adjunct to ACL reconstruction.^[12] The minimal donor site morbidity observed is comparable to standard procedures and does not pose additional risks to patients.^[13]

Contrastingly, some studies have found no significant benefits of PRP in ACL reconstruction.^[14,15] This discrepancy may stem from variations in PRP preparation, concentration, activation methods, and application techniques.^[8] Our study utilized a standardized PRP protocol with a high platelet concentration and activation, which may have contributed to the positive outcomes.

The mechanism by which PRP enhances graft healing is thought to involve the release of growth factors such as platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF- β), and vascular endothelial growth factor (VEGF), which promote cell proliferation, angiogenesis, and collagen synthesis.^[16]

Limitations of this study include a relatively short follow-up period and the absence of long-term outcome data. Additionally, while MRI provides valuable insights into graft maturation, it may not fully capture the complex biological processes involved. Future studies with longer follow-up and histological assessments could provide more comprehensive understanding.

CONCLUSION

PRP augmentation in ACL reconstruction appears to enhance graft maturation and improve early functional outcomes without increasing complications. These findings support the use of PRP as a biologic adjunct in ACL surgery. Further long-term studies are warranted to assess the sustained benefits and to optimize PRP preparation and application methods for enhanced patient outcomes.

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