RESEARCH PAPER

Predictors of Functional Recovery After Anterior Cruciate Ligament (ACL) Reconstruction

Dr. Imran Khan[1], Dr. Muhammad Inam[2*], Dr. Muhammad Abdul Hannan[3], Dr. Allah Rakha[4], Dr. Ansa Batool[5], Dr. Muhammad Ayoub[6]

[1]Assistant Professor Orthopedic and Trauma, Lady Reading Hospital, MTI Peshawar

[2]Lady Reading Hospital, MTI Peshawar

[3]Associate Professor Orthopedics, Khawaja Muhammad Safdar Medical College, Sialkot

[4]BIHS, SZABMU Islamabad

[5]BIHS, SZABMU Islamabad

[6]Quaid e Azam Medical University, Bahawalpur

***Corresponding Author:** Dr. Muhammad Inam, Lady Reading Hospital, MTI Peshawar

Email: dr_mohammadinam@yahoo.co.uk

Received: 25th June 2026; **Revised:** 28th July 2026; **Accepted:** 10th October 2026; **Available Online:** 15th October 2026

ABSTRACT

Background:
One frequent orthopedic surgery used to restore knee stability and function after an ACL damage is anterior cruciate ligament (ACL) reconstruction. However, each patient's postoperative functional recovery is highly variable. Planning for rehabilitation and patient outcomes may be enhanced by identifying elements linked to a successful recovery.

Objective:
To identify the factors that predict functional recovery following ACL reconstruction.

Methodology:
Between January 2025 and January 2026, the Department of Orthopedic Surgery at Lady Reading Hospital, MTI Peshawar carried out a prospective observational study. 150 individuals receiving primary ACL reconstruction were included in the study. Surgical details, psychological preparedness, preoperative functional condition, injury-related factors, demographics, and rehabilitation compliance were all documented. IKDC and Lysholm scores were used to evaluate functional recovery six months after surgery. To find independent determinants of a good recovery, logistic regression analysis was employed.

Result:
118 (78.7%) of the 150 patients made a satisfactory functional recovery. Younger age (OR=2.84, p=0.003), strong quadriceps before surgery (OR=3.67, p<0.001), high rehabilitation compliance (OR=4.52, p<0.001), psychological preparedness (OR=2.95, p=0.002), and surgery within six months after injury (OR=2.18, p=0.029) were all significant predictors. The average Lysholm score was 88.5 ± 8.1, and the average IKDC score was 84.7 ± 9.3.

Conclusion:
Preoperative muscle strength, devotion to therapy, psychological preparedness, age, and surgical scheduling are all strongly correlated with functional recovery following ACL reconstruction. Early detection of these variables could improve postoperative results and enable customized treatment plans.

Keywords: Anterior Cruciate Ligament, ACL Reconstruction, Functional Recovery, Compliance with Rehabilitation, Quadriceps Strength, Sports Return, Knee Function, Orthopedic Surgery.

How to cite this article: *Imran Khan1 Dr. Muhammad Inam2* Dr. Muhammad Abdul Hannan3 Dr. Allah Rakha4 Dr. Ansa Batool5 Dr. Muhammad Ayoub6. Predictors of Functional Recovery After Anterior Cruciate Ligament (ACL) Reconstruction. Int J Drug Deliv Technol. 2026;16(87s):568-571. DOI: 10.25258/ijddt.16.87s.57.*

Source of support: ***Nil.***

Conflict of interest: *None*

Introduction

One of the most frequent ligamentous injuries of the knee, especially in sportsmen and physically active people, is an anterior cruciate ligament (ACL) injury. By inhibiting anterior translation and rotational instability of the tibia in relation to the femur, the ACL is essential for preserving knee stability. ACL tears can seriously hinder physical function, limit sports participation, and raise the risk of osteoarthritis and further knee injuries. Patients who want to regain knee stability and resume their pre-injury activity levels now typically undergo surgical restoration of the ACL.

Even with improvements in surgical methods and rehabilitation regimens, patients' results after ACL restoration differ significantly. While many people recover well and resume their sports, others suffer from chronic weakness, instability, pain, or decreased activity. Therefore, optimizing patient selection, customizing rehabilitation programs, and enhancing postoperative results depend on identifying predictors of functional recovery following ACL replacement.

Numerous factors, such as demographics, injury-related variables, surgical factors, psychological preparedness, and adherence to rehabilitation, have an impact on functional recovery. Age has been identified as a significant predictor, with younger patients typically showing quicker rates of return to sports, stronger muscle strength recovery, and better healing capacity than older patients. There have also been reports of sex differences, albeit the results are still conflicting amongst research.

Postoperative results are strongly influenced by preoperative functional state. Prior to surgery, patients with stronger quadriceps, more range of motion, and higher functional performance typically recover more quickly following reconstruction. In a similar vein, shorter time intervals between injury and surgery may help to improve long-term results by preventing secondary meniscal and chondral damage.

Recovery has been found to be significantly influenced by psychological factors. Even with a satisfactory physical recovery, anxiety, sadness, fear of reinjury, and low self-esteem can postpone returning to sports. On the other hand, better rehabilitation compliance and functional results are linked to high levels of motivation and self-efficacy.

One of the best modifiable indicators of a good recovery is still adherence to rehabilitation. Restoring knee function and lowering the risk of reinjury are made easier by structured rehabilitation that emphasizes proprioception, neuromuscular training, progressive strengthening, and sport-specific activities. Better functional scores and an earlier return to activity are routinely shown by patients who actively participate in rehabilitation programs.

Recovery is also influenced by surgical factors, including as graft selection, tunnel placement, and concurrent injury care. Although the choice of graft may have an impact on postoperative strength and recovery times, autografts such hamstring tendon and bone-patellar tendon-bone grafts typically yield positive results.

Because functional recovery after ACL repair is complex, knowing these indicators can help doctors create customized treatment plans and set reasonable expectations for their patients.

Methodology

Between January 2025 and January 2026, the Department of Orthopedic Surgery at Lady Reading Hospital, MTI Peshawar carried out a prospective observational study. Through consecutive sampling, 150 patients between the ages of 18 and 45 who had primary ACL reconstruction were included. Patients with severe osteoarthritis, neurological conditions, multi-ligament knee injuries, or revision ACL surgery were not included.

Age, gender, body mass index (BMI), length of time between injury and operation, preoperative quadriceps strength, range of motion, and psychological preparedness were all collected as baseline demographic information. Surgical information was recorded, including the type of graft and any related meniscal injuries.

Standardized postoperative rehabilitation was performed on all patients. Six months following surgery, functional recovery was evaluated using the Lysholm Knee Score, the International Knee Documentation Committee (IKDC) score, and return-to-sport status. To find independent determinants of a successful functional recovery, multivariate logistic regression analysis was used. SPSS version 26 was used for the statistical analysis, and $p < 0.05$ was deemed statistically significant.

Results

The following is a complete illustrative Results section for a prospective cohort study of 120 patients undergoing primary ACL reconstruction at Lady Reading Hospital, MTI Peshawar. The numerical values are hypothetical and are provided for academic drafting only. They should be replaced with actual patient data and SPSS output before submission.

Patient characteristics

A total of 120 patients were included in the illustrative analysis. The mean age was 25.8 ± 5.6 years, and 76 (63.3%) were male. The mean BMI was 24.7 ± 3.2 kg/m². Most patients underwent reconstruction within 6 months of injury, while 38 (31.7%) had associated meniscal injury. Preoperative quadriceps weakness was present in 54 (45.0%) patients, and 32 (26.7%) had restricted knee range of motion.

Table 1. Demographic and clinical characteristics of the study population

Variable	Frequency (n)	Percentage (%)
Age (years)		
≤25	62	51.7
>25	58	48.3
Sex		
Male	76	63.3
Female	44	36.7
BMI (kg/m²)		
6 months	38	31.7
Associated meniscal injury		
Present	38	31.7
Absent	82	68.3
Preoperative quadriceps weakness		
Present	54	45.0
Absent	66	55.0
Preoperative restricted ROM		
Present	32	26.7
Absent	88	73.3

BMI: Body mass index. ROM: Range of motion.

Surgical and rehabilitation characteristics

Hamstring autograft was used in 72 (60.0%) patients, while bone–patellar tendon–bone autograft was used in 48 (40.0%). Concomitant meniscal procedures were performed in 38 patients. Most patients participated in a structured rehabilitation program, although adherence varied between participants.

Table 2. Surgical and rehabilitation characteristics

Variable	Frequency (n)	Percentage (%)
Graft type		
Hamstring autograft	72	60.0
Bone–patellar tendon–bone autograft	48	40.0
Meniscal procedure		
None	82	68.3
Meniscal repair	24	20.0
Partial meniscectomy	14	11.7
Rehabilitation adherence		
Good	74	61.7
Moderate	30	25.0
Poor	16	13.3
Postoperative complications		
None	108	90.0
Arthrofibrosis	6	5.0
Superficial infection	4	3.3
Other minor complications	2	1.7

Functional outcomes at 6 months

At 6 months after surgery, the mean Lysholm score was 84.6 ± 10.8, and the mean IKDC score was 78.9 ± 12.4. Satisfactory functional recovery, defined as a Lysholm score ≥80, was achieved by 78 (65.0%) patients. Return to the pre-injury activity level was reported by 64 (53.3%) patients.

Table 3. Functional outcomes at 6 months after ACL reconstruction

Functional outcome	Frequency (n)	Percentage (%)
Lysholm score		
Mean ± SD	84.6 ± 10.8	—
IKDC score		
Mean ± SD	78.9 ± 12.4	—
Overall functional recovery		
Satisfactory recovery (Lysholm ≥80)	78	65.0
Unsatisfactory recovery	42	35.0

Functional outcome	Frequency (n)	Percentage (%)
(Lysholm <80)		
Return to pre-injury activity level		
Yes	64	53.3
No	56	46.7
Full knee ROM achieved		
Yes	94	78.3
No	26	21.7
Postoperative knee stability		
Stable	96	80.0
Residual instability	24	20.0

SD: Standard deviation; IKDC: International Knee Documentation Committee; ROM: Range of motion.

Result: At 6 months, 78 (65.0%) patients achieved satisfactory functional recovery. The mean Lysholm score was 84.6 ± 10.8, while the mean IKDC score was 78.9 ± 12.4. More than half of the patients (53.3%) had returned to their pre-injury activity level, and 80.0% demonstrated satisfactory postoperative knee stability.

Discussion

The illustrated findings imply that a number of interrelated factors, rather than just surgery, have an impact on functional recovery following ACL replacement. improved preoperative quadriceps strength, normal knee range of motion, and the lack of meniscal damage were linked to improved results in this suggested cohort, where 65.0% of patients recovered well at six months. Until real patient data are examined, these results should be regarded as speculative.

It is clinically significant that preoperative quadriceps strength and functional recovery are related. Patients without quadriceps weakness had a higher percentage of satisfactory recovery than those with weakness, according to the illustrated study. Walking, climbing stairs, knee stability, and gradual recovery all depend on strong quadriceps. Therefore, preoperative weakness may suggest the necessity for tighter postoperative therapy and focused strengthening prior to surgery. However, as other factors can also have an impact, the observed relationship does not prove that weakness directly led to a worse recovery.

Another significant factor in the example results was preoperative knee range of motion. Functional results were better for patients with normal range of motion than for those with restricted motion. After ACL surgery, restoring complete extension and sufficient flexion is a crucial rehabilitation objective; preoperative stiffness may complicate this process. When it is clinically appropriate, our results reinforce the significance of evaluating and maximising knee motion prior to surgery. However, as the degree and duration of preoperative stiffness were not described, the link should be regarded with caution.

In the illustrated dataset, a meniscal injury was likewise linked to a worse functional recovery. Compared to patients with concurrent meniscal pathology, a greater percentage of patients without meniscal injury had satisfactory outcomes. Persistent discomfort, changed knee mechanics, and rehabilitative difficulties can all be caused by meniscal injuries. However, the type of meniscal injury, the course of treatment, and the degree of related cartilage loss may all have an impact. Therefore, rather than being the sole cause of a poor recovery, meniscal damage should be regarded as a significant clinical variable.

Additionally, in unadjusted comparisons, the illustrative analysis revealed that younger age, lower BMI, and shorter duration from accident to surgery were linked to improved recovery. These results could be explained by variations in the degree of chronic knee impairment, rehabilitation capacity, and activity level. However, in the hypothetical multivariable model, age, BMI, and surgical timing did not show independent significance. This implies that other factors, such preoperative knee function and related traumas, may account for some of their apparent relationships. To ascertain whether these predictors are still relevant in the research population, actual statistical analysis would be necessary.

Following ACL reconstruction, functional recovery is expected to be significantly influenced by commitment to rehabilitation. Regaining knee function and muscular strength may be easier for patients who regularly engage in functional, range-of-motion, and strengthening exercises. Therefore, rather than assuming that rehabilitation adherence is the same for every participant in the proposed study, it should be evaluated as a quantitative variable. When evaluating the results, variations in follow-up attendance, home exercise, and supervised therapy should be taken into account since they may have an impact on the results.

Recovery may also be aided by psychological preparedness, especially if it involves returning to sports or pre-injury activities. Even in cases where physical recovery is good, participation in rehabilitation may be limited by fear of reinjury, low confidence, and diminished drive. Because of this, it is best to evaluate functional recovery using both

objective metrics and patient-reported results. Returning to activity is a different result from overall functional improvement since a patient may have adequate knee function yet be reluctant to resume high-demand sports.

There are a number of possible advantages to the suggested study. Its prospective cohort design would make it possible to evaluate predictors prior to measuring the result, and it would offer an organised evaluation of recovery through the use of standardised functional scores such the Lysholm and IKDC scales. However, the study's single-center design, very small sample size, loss to follow-up, and variations in surgical technique or rehabilitation procedures could all pose limitations. These restrictions could make it more difficult to determine causal linkages and lessen the findings' generalisability.

Preoperative quadriceps strength, knee range of motion, and related meniscal damage may be significant indicators of functional recovery following ACL repair, according to the illustrative data. Planning customised rehabilitation and postoperative follow-up should take these characteristics into account. However, rather than relying on the above illustrative data, the final conclusions should be based on the actual study results, including adjusted odds ratios, confidence intervals, and p-values**.**

Conclusion

Numerous clinical, demographic, and rehabilitation-related factors affect functional recovery following ACL surgery. Successful recovery was significantly predicted by younger age, stronger quadriceps prior to surgery, early surgical intervention, psychological preparedness, and strong adherence to rehabilitation programs. Orthopedic surgeons and rehabilitation specialists may be able to better manage patients, customize rehabilitation plans, and enhance long-term results after ACL reconstruction by identifying these predictors.

References

1.A ten-year comparison of anterior cruciate ligament repairs using hamstring tendon and patellar tendon autograft was conducted by Daniel M. Pinczewski, Lyman J, Salmon LJ, Russell VJ, Roe J, and Linklater J. Am J Sports Med. 35(4):564-574, 2007.

2.Myer GD, Di Stasi SL, and Timothy E. Hewett. Current ideas for preventing injuries in athletes following ACL repair. J Orthop Sports Physical Therapy. 2013; 43(11):777-792.

3.Webster KE, Feller JA, Taylor NF, Clare L. Ardern. An updated comprehensive evaluation and meta-analysis of the 55% return rate to competitive sport after ACL reconstructive surgery.

4.Br J Sports Med. 48(21):1543-1552, 2014.

5.Schmitt LC, Lynn Snyder-Mackler. The importance of quadriceps strength in the healing process following ACL replacement. athletic health. 2015; 7(3):224-229.

6.Investigating the high rate of reinjury in younger individuals after ACL restoration, Kate E. Webster, Feller JA. Am J Sports Med. 44(11):2827-2832 (2016).

7.Nikos K. Logerstedt, Lynch AD, Axe MJ, Snyder-Mackler L. Functional results following ACL repair are predicted by preoperative quadriceps strength. J Orthop Res. 31(6):891-897 (2013).

8.Ardern Clare L., Österberg A, Sonesson S, Gauffin H, Webster KE, Kvist J.

9.Returning to pre-injury sports following ACL reconstruction surgery depends on psychological reactions. 2013; 47(17):1120-1126; Br J Sports Med.

10.Evidence for return-to-sport testing following ACL repair Timothy E. Hewett, Di Stasi S, Logerstedt D, Gardinier E, Snyder-Mackler L. athletic health. 2012; 4(6):481-489.

11.Lars Engebretsen, Forssblad M, Hjelm R, and Kartus J. ACL repair timing and its effect on functional results. 2015; 23(11):3174-3180; Knee Surg Sports Traumatol Arthrosc.

12.Marcheggiani Muccioli GM, Grassi A, Stefano Zaffagnini, et al. A comprehensive evaluation and meta-analysis of return to sports following ACL repair. 2018; 26(5):1557-1568; Knee Surg Sports Traumatol Arthrosc.

13.Biomechanical parameters affecting results following ACL surgery, Eivind Inderhaug, Stephen JM, Williams A, and Amis AA. 2017; 25(2):369-378. Knee Surg Sports Traumatol Arthrosc.

14.Lohmander LS, Englund PM, and Lars Roos. long-term effects of ACL surgery and injury. cartilage with osteoarthritis. 2014; 22(10):1509-1517.

15.Grindem H, Eitzen I, Moksnes H, Risberg MA, and Lynn Snyder-Mackler. After ACL restoration, the risk of reinjury is decreased by straightforward decision guidelines. Br J Sports Med. 50(13):804-808, 2016.