



Comparison of Functional Outcome between Early Versus Delayed Arthroscopic Anterior Cruciate Ligament Reconstruction

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Abstract

Background: The anterior cruciate ligament is a crucial stabilizer of the knee joint & its injury can lead to significant functional impairment, particularly in active individuals & professional athletes. The management of anterior cruciate ligament injuries, particularly the timing of surgical reconstruction, remains a debated topic in orthopedics and sports medicine.

Aim of the study: To compare the functional outcome between early versus delayed arthroscopic assisted anterior cruciate ligament reconstruction by quadruple strand hamstring autograft.

Methods: This prospective comparative study was conducted in the Department of Orthopaedic Surgery at Bangladesh Medical University from September 2022 to March 2025. A total of 44 patients were selected according to selection criteria and randomly assigned to two groups: Early (≤ 3 weeks) and Delayed (> 3 weeks) groups depending on duration of injury & performed anterior cruciate ligament reconstruction by quadruple strand hamstring autograft. Assessments were performed both preoperatively and postoperatively at 1, 3, 6, and 9 months, using clinical and radiological evaluations. The functional outcomes were measured and compared using the Lysholm Score, Tegner Activity Score and range of knee motion. The analysis of various variables conducted following standard statistical methods with Statistical Package for Social Science version 26. Statistical significance determined at p -value < 0.05 with a confidence interval at 95% were significant for all analyses.

Result: The study population had a mean age of 29.41 ± 6.41 years, with 54.6% of participants were in 20-29 age range. Sports-related activities were the primary cause of injuries, accounting for 47.7% followed by road traffic accidents (RTAs) were at 38.6%. There were no significant differences between groups regarding demographic variables. Average graft diameter in early group was 7.4 ± 0.5 & delayed group was 7.5 ± 0.4 . Post-surgery, 90% of the Early Group and 86.4% of the Delayed Group had negative anterior drawer test; respectively 86.4% and 81.8% had negative Lachman test. At final follow-up, Lysholm scores significantly improved to 90.14 ± 3.82 (82 to 96) for the Early Group and 88.59 ± 4.19 (80 to 94) for the Delayed Group ($p=0.241$). The Tegner activity score was 5.91 ± 1.02 (5-8) in the Early Group and 5.86 ± 0.71 (5-7) in the Delayed Group ($p=0.841$). In the Early Group, 63.6% achieved excellent outcomes, 31.8% rated as good, and 4.5% noted as fair. The Delayed Group displayed 50% with excellent outcomes, 40.9% were good, and 9.1% were marked as fair. Importantly, no participants in either group had experienced poor outcomes ($p=0.624$).

Conclusion: This study demonstrates that the functional outcomes of an anterior cruciate ligament reconstruction didn't depend on the timing of the surgery, though a small difference in Lysholm score and Tegner activity and range of knee motion was in favor of early anterior cruciate ligament reconstruction over delayed reconstruction.

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Citation: Aminur Rasul, Abu Zaffar Chowdhury, Chowdhury Iqbal Mahmud, Debashish Dey⁴, Golam Shaikh Ferdous, Aynun Nahar Rabeya Diba, Nazrul Islam. Comparison of Functional Outcome between Early Versus Delayed Arthroscopic Anterior Cruciate Ligament Reconstruction. Journal of Orthopedics and Sports Medicine. 7 (2025): 479-485.

Received: August 30, 2025

Accepted: September 16, 2025

Published: September 30, 2025

Keywords: Anterior cruciate ligament; Arthroscopic reconstruction; Rehabilitation; Knee stability; Lysholm score

Introduction

Ruptures of the anterior cruciate ligament (ACL) are among the most common & impactful injuries in athletes leading to an incidence ranging from 8 to 52 cases per 100,000 individuals annually in developed nations [1]. These injuries generally occur when the biomechanical limits of the ligament are exceeded, either as a result of direct trauma or indirect non-contact mechanism. Direct trauma is often associated with road traffic accidents & contact sports whereas, non-contact ACL injuries are more common in sports that involve pivoting, sudden stops, and deceleration during running [2]. ACL injuries can be managed through either conservative or surgical intervention. Conservative treatments frequently fail to produce the anticipated outcomes & primary repair technique often yield ACL unsatisfactory results. Anatomic ACL reconstruction effectively restores the stability of the knee joint, enabling individuals to resume sports and daily activities. As a result, ACL reconstruction is widely regarded as the gold standard procedure for maintaining knee stability and reducing the further cartilage and meniscal damage, particularly in active individuals and athletes. Additionally, this surgical approach facilitates quicker return to pre-injury functional capabilities [3]. Now-a-days, ACL reconstruction often performed on a day care basis within 48 hours after an injury [4]. Even now ACL reconstruction following accelerated rehabilitation protocol in a median recovery period of only 59.5 days before professional athletes can return to training [5]. Despite this success, debates & clinical uncertainties persist regarding key aspects of optimal reconstruction. These includes the use of single versus double bundle grafts, the role of biological support in graft maturation and the necessity of bracing during postoperative rehabilitation [6-8]. Early intervention-within days to weeks after an injury is believed to expedite the regaining of tibiofemoral stability, consequently decreasing additional chondral and meniscal damage. This approach is associated with fewer degenerative joint diseases [9]. Additionally, early surgery offers economic advantages and facilitates a faster return to function, which is crucial for achieving better long-term outcomes [10]. Nevertheless, some critics warn that performing surgery too early could elevate the risk of postoperative stiffness and complications related to lingering inflammation or swelling [11]. In contrast, delayed ACL reconstruction includes a preoperative rehabilitation phase aimed at minimizing swelling, enhancing range of motion, and strengthen surrounding muscles. This approach is frequently suggested for patients experiencing significant acute inflammation or those who could gain from improved knee function prior to surgery. Advocates of delayed reconstruction argue that it results in more favorable

postoperative outcomes, preoperative improvement in range of motion (ROM), and better soft tissue conditioning, which can lower the incidence of wound complications and arthrofibrosis [12]. Another benefit of delaying surgery is that patients can mentally prepare and set realistic recovery goals in advance. However, delaying surgery can lead to muscle atrophy, potentially hindering rehabilitation and increasing the risk of further knee injuries, especially in active individuals who continue to stress an unstable joint [1]. The aim of this study was to evaluate and compare the functional outcomes of early and delayed ACL reconstruction.

Methodology and Materials

This meticulously conducted prospective comparative study was executed in the Department of Orthopaedic Surgery at BMU, Shahbagh, Dhaka. Spanning from September 2022 to March 2025, the study systematically investigated functional outcomes of patients with isolated anterior cruciate ligament (ACL) injuries. Employing a purposive sampling strategy, a total of 44 patients attending the outpatient department were enrolled to form a well-defined study Participants were carefully allocated into two distinct groups based on the duration of their injury:

Early Group (n=22): Patients operated within 3 weeks of injury.

Delayed Group (n=22): Patients operated after 3 weeks of injury.

Inclusion Criteria

- Age between 18-45 years
- Patients with a diagnosed case of isolated ACL injury.
- Arthroscopic ACL reconstruction in Group A (within 3 weeks of injury) & Group B (After 3 weeks of injury)

Exclusion Criteria

- Patient with old ACL injury (>1year as there is more chance of chondral and meniscal injury) & multi-ligament knee injury
- Presence of associated meniscal or cartilage injuries & fractures around the knee (femoral condyle, tibial plateau, patella)
- History of previous knee surgeries
- Diagnosed knee osteoarthritis
- Knee sepsis and loss of motion due to acute injury
- Patients unfit for surgical procedures
- Patients who do not give consent

Data collection

A structured case record form was employed to

systematically gather all relevant data. Independent variables included demographic parameters (age, gender, occupation, BMI) and clinical parameters (duration of injury, injured side, mechanism of injury, Anterior Drawer Test, Lachman Test). Dependent variables comprised primary outcomes (Lysholm Score, Tegner Activity Score) and secondary outcomes (knee range of motion, postoperative complications). All patients underwent arthroscopic ACL reconstruction using a quadruple hamstring autograft under standard aseptic conditions. Patients were evaluated preoperatively and followed up at 1, 3, 6, and 9 months postoperatively, with functional outcomes assessed at each visit. Perioperative events, complications, and knee stability (assessed by Anterior Drawer Test and Lachman Test) were meticulously recorded. Ethical approval was obtained from the Institutional Review Board of BMU, and written informed consent was secured from all participants.

Statistical analysis

Data were analyzed using SPSS version 26. Continuous variables were summarized as mean±standard deviation, and categorical variables as frequency and percentage. Parametric data were compared using the Student's t-test, non-parametric data with the Mann-Whitney U test, and categorical data via chi-square test. A p-value ≤0.05 was considered statistically significant, with a 95% confidence interval.

Result

A total of 44 patients were included, equally divided into early (n=22) and delayed (n=22) reconstruction groups. The mean age was comparable between the groups (30.14±5.89 vs. 29.41±7.02 years, p=0.549), with the majority belonging to the 20–30 years age group (54.55%). Males were predominant (86.36%), and the right knee was more frequently affected (61.36%). Distribution of occupation, BMI, and mechanism of injury showed no significant intergroup differences. Most

patients had a normal BMI (79.55%) and sustained injury during sports activity (47.73%) or road traffic accidents (38.64%) (Table 1). Operative and clinical parameters revealed a highly significant difference in the mean duration of injury between groups (13.32±3.37 vs. 106.00±56.20 days, p=0.001). Graft diameter was similar (7.4±0.5 vs. 7.5±0.4 mm, p=0.468). Preoperatively, the majority demonstrated Grade III laxity on anterior drawer (72.73%) and Lachman (81.82%) tests. Postoperatively, both groups showed marked improvement, with most patients achieving Grade 0 stability on anterior drawer (88.64%) and Lachman (84.09%) tests, with no significant differences between groups (Table 2). Functional outcomes improved substantially in both groups in Table 3. The mean preoperative Lysholm score was 54.32±6.76 in the early group and 56.59±5.11 in the delayed group (p=0.148). At final follow-up, the scores improved to 90.14±3.82 and 88.59±4.19 respectively (p=0.241). Preoperative Tegner activity scores were slightly higher in the delayed group (6.86±1.21 vs. 6.41±1.20), but postoperative scores were nearly identical (5.91±1.02 vs. 5.86±0.71, p=0.841). Postoperative knee ROM was well preserved in both groups, with mean values of 134.77±3.27° and 134.09±2.94° respectively (p=0.481). Postoperative complications were minimal and did not differ significantly. Paresthesia occurred in 13.64% of early and 18.18% of delayed cases, while superficial infection and knee stiffness were noted in one patient per group (4.55%). The majority of patients remained free of complications (77.27% vs. 72.73%) (p=0.982). Regarding final functional outcome (Lysholm categories), excellent results (score 91–100) were achieved in 63.64% patients of the early group and 50.00% of the delayed group (Table 4). Good results (score 84–90) were seen in 31.82% and 40.91% patients respectively, while fair results (score 65–83) were noted in 4.55% and 9.09% patients. No statistically significant difference was observed (p=0.624).

Table 1: Baseline demographic and clinical characteristics of the study population (N = 44).

Variable	Early Group (n= 22)		Delayed Group (n= 22)		Total (n= 44)		p-value
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	
Age							
20-30 years	11	50	13	59.09	24	54.55	0.598
31-40 years	10	45.45	7	31.82	17	38.64	
41-45 years	1	4.55	2	9.09	3	6.82	
Mean± SD	30.14 ± 5.89		29.41 ±7.02		29.41 ±6.41		0.549
(Min-Max)	(21-42)		(21-45)		(21-45)		
Gender							
Male	18	81.82	20	90.91	38	86.36	0.38
Female	4	18.18	2	9.09	6	13.64	
Involved site							
Right	15	68.18	12	54.55	27	61.36	0.353
Left	7	31.82	10	45.45	17	38.64	
Occupation							

Student	8	36.36	7	31.82	15	34.09	0.496
Service Holder	4	18.18	7	31.82	11	25	
Athlete	3	13.64	5	22.73	8	18.18	
Business	6	27.27	2	9.09	8	18.18	
Homemaker	1	4.55	1	4.55	2	4.55	
BMI							
18.5- 24.9 (normal)	17	77.27	18	81.82	35	79.55	0.466
25-29.9 (overweight)	5	22.73	3	13.64	8	18.18	
>30 (Obese)	0	0	1	4.55	1	2.27	
Mean ±SD	23.95 ±2.22		23.98 ±2.27		23.96 ±2.21		0.972
(Min- Max)	(20.40- 28.10)		(19.80- 30.40)		(19.80- 30.40)		
Mechanism of Injury							
Sports Activity	10	45.45	11	50	21	47.73	0.679
Road Traffic Accident	8	36.36	9	40.91	17	38.64	
Domestic Accidents	4	18.18	2	9.09	6	13.64	

Table 2: Operative and clinical parameters between early and delayed groups (N = 44).

Variable	Early Group (n= 22)		Delayed Group (n= 22)		p-value
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	
Duration of Injury (days)					
Mean ±SD	13.32 ±3.37		106.00 ±56.20		0.001*
(Min- Max)	(7-20)		(28-240)		
Graft diameter					
Mean ±SD	7.4±0.5		7.5±0.4		0.468*
(Min- Max)	(6.5-8)		(7-8)		
Anterior Drawer Test (Pre-operative)					
Grade II	7	31.82	5	22.73	0.498*
Grade III	15	68.18	17	77.27	
Anterior Drawer Test (Post-operative)					
Grade 0	20	90.91	19	86.36	0.635*
Grade I	2	9.09	3	13.64	
Lachman Test (Pre-operative)					
Grade II	5	22.73	3	13.64	0.434
Grade III	17	77.27	19	86.36	
Lachman Test (Post-operative)					
Grade 0	19	86.36	18	81.82	0.680*
Grade I	3	13.64	4	18.18	

Table 3: Postoperative functional assessment between early and delayed groups (N = 44).

Clinical Outcome	Early Group (n= 22)	Delayed Group (n= 22)	p-value
Lysholm Score			
Pre-operative	54.32 ±6.76	56.59 ±5.11	0.148
(Min- Max)	(44- 67)	(47- 68)	
Lysholm Score			
Post-operatively at Final follow up	90.14 ±3.82	88.59 ±4.19	0.241
(Min- Max)	(82- 96)	(80- 94)	
Tegner Activity Score			
Pre-operative	6.41 ±1.2	6.86 ±1.21	0.192
(Min- Max)	(5-9)	(5-9)	
Post-operatively at Final follow up	5.91 ±1.02	5.86 ±0.71	0.841
(Min- Max)	(5-8)	(5-7)	
Knee ROM			
Post-operatively at Final follow up	134.77 ±3.27	134.09 ±2.94	0.481
(Min- Max)	(130-140)	(130-140)	

Table 4: Postoperative complications and final results between early and delayed groups (N = 44).

Complications and Functional Outcome	Early Group (n= 22)		Delayed Group (n= 22)		p-value
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	
Complications					
Paresthesia	3	13.64	4	18.18	0.982
Superficial infection	1	4.55	1	4.55	
Knee Stiffness	1	4.55	1	4.55	
None	17	77.27	16	72.73	
Final Outcome (Lysholm Score)					
Excellent (91-100)	14	63.64	11	50	0.624
Good (84-90)	7	31.82	9	40.91	
Fair (65- 83)	1	4.55	2	9.09	

Discussion

The average age of patients in the Early and Delayed Groups was 30.14±5.89 (21-42) years and 29.41±7.02 (21-45) years respectively. A majority of the patients (54.6%) were between the ages of 20-30. Similarly, research by Chen et al. [13, Hur et al. [14] and Reijman et al. [15] reported mean ages of 29.4, 30.1, and 31.2 years for early cases, and 31.9, 30.0, and 31.4 years for delayed cases [13-15]. In the Early and Delayed Groups, males represented 81.8% and 90.9% of cases, respectively, while females made up 18.2% and 9.1%. No significant difference between the groups was observed (p=0.380). This finding aligns with the research by Salahuddin et al. [16], which reported 88.8% and 86.6% male cases in early and delayed groups, respectively [16]. The right

knee was more involved than the left in both groups, with 68.2% in the Early Group and 54.5% in the Delayed Group. It was comparable to the study done by Manandhar et al. [17] and Zaman et al. [18], where 61.5% and 58.33% of the cases had right knee involvement [17,18]. The majority of patients were students, accounting for 34.1%. A demographic analysis of ACL injuries conducted in a tertiary center in Bangladesh indicated that students were the most affected group, at 43.3%, followed by service holders at 33.3% [18]. The average BMI was 23.95±2.22 for the Early Group and 23.98±2.27 for the Delayed Group, with 79.5% of patients maintaining normal BMI. This study was similar to the study done by Salahuddin et al. [16], where 89.1% of the cases maintained normal BMI (89.1%) [16]. Sports-related activities caused 47.7%

of injuries, Road Traffic Accidents 38.6%, and domestic accidents 13.6%. Reviewing the literature, the most common mechanism for ACL injury was related to sports activity ranging from 40-78% of the cases [17-20]. This observation can be explained by the fact that the study population consists mainly of young individuals, predominantly students, who engage in recreational sports. Post-surgery, ADT was negative in 90% of the Early Group and 86.4% in the Delayed Group ($p=0.635$). Also, Lachman test was negative in 86.4% (Early Group) and 81.8% (Delayed Group) ($p=0.680$). This was comparable to the study conducted by Rahman et al. [21], in which 90% and 96.67% of the patients undergoing ACLR with autologous hamstring grafts had negative Lachman and Anterior Drawer tests, respectively [21]. Before the operation, the Lysholm Score was 54.32 ± 6.76 (44-67) in the Early Group and 56.59 ± 5.11 (47-68) in the Delayed Group. At the final follow-up, scores improved significantly to 90.14 ± 3.82 (82-96) for the Early Group and 88.59 ± 4.19 (80-94) for the Delayed Group. The findings align with those of Rejiman et al. [15], who reported a mean score of 88.8 points for the early group and 84.5 points for the delayed group at the 9-month follow-up [15]. Before the operation, the pre-injury Tegner Activity Score was 6.41 ± 1.2 (5-9) for the Early Group and 6.86 ± 1.21 (5-9) for the Delayed Group. At the final follow-up, scores were 5.91 ± 1.02 (5-8) in the Early Group and 5.86 ± 0.71 (5-7) in the Delayed Group. The results were comparable to the study done by Hur et al. [14], where mean Tegner score was 6.0 ± 1.6 in early and 5.6 ± 1.5 in delayed group [14]. Post-surgery, the Knee range of motion (ROM) was $134.77 \pm 3.27^\circ$ (130-140) in the Early Group and $134.09 \pm 2.94^\circ$ (130-140) in the Delayed Group. The results were comparable to the study done by Hur et al. [14], where mean ROM was 138.6 ± 4.1 in the early and 138.8 ± 5.6 in the delayed group [14]. Paresthesia at the graft site was most common complication in 13.6% and 18.2% of cases in the Early and Delayed Groups, respectively. Superficial portal site infection and knee stiffness were seen in 1 (4.5%) case each in both groups ($p=0.982$). In the Early Group, 63.6% of cases achieved excellent outcomes, 31.8% were rated good, and 4.5% had fair outcomes. In contrast, the Delayed Group showed that 50% had excellent outcomes, 40.9% were good, and 9.1% were considered fair. Notably, neither group experienced poor outcomes. A systematic review and meta-analysis by Ferguson et al. [22] and Shen et al. [23], concluded that currently, there is no definitive evidence to establish the superiority of acute/early versus delayed reconstruction of a ruptured anterior cruciate ligament in terms of knee stability, knee range of motion, adverse complications and functional outcomes [22,23].

Limitations of the Study

The study has several limitations that should be acknowledged. The use of purposive sampling introduces

a potential selection bias, which could have influenced the results. Additionally, only patients with isolated ACL injuries were included in both study groups, suggesting that the selected population was more likely to experience favorable outcomes. In contrast, the presence of concomitant injuries, such as meniscal tears or chondral lesions, could have affected the results, as rehabilitation protocols would need to be tailored according to the specific nature of those injuries. Furthermore, the relatively short post-operative follow-up period may limit the ability to fully assess long-term functional outcomes and complications.

Conclusion and Recommendations

This study shows that ACL reconstruction, whether early or delayed, leads to significant functional improvements. Surgical timing does not notably impact outcomes like knee stability, range of motion, or adverse events. However, early reconstruction showed some superiority in Lysholm, Tegner scores and also fewer post-operative complications. Overall, both early & delayed surgery options offer flexibility in surgical timing.

Recommendations

1. Conducting a randomized control trial (RCT) for more robust and unbiased result.
2. Implementing a multicenter study to ensure broader representation of the target population.
3. Extending the follow-up period to assess long-term outcomes comprehensively.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee.

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