

Assessment of Early versus Delayed Arthroscopic Intervention in Acute ACL Injuries: Effect on Meniscal Injury Rates and Postoperative Stiffness**Ravi Pratap Singh¹, Gaurav Singh², Saurabh Singh³, Vishnu Pratap Singh⁴**¹Assistant Professor, Dept. of Orthopedics, T.S. Misra Medical College and Hospital, Lucknow, UP, India²Assistant Professor, Dept. of Orthopedics, T.S. Misra Medical College and Hospital, Lucknow, UP, India³Associate Professor, Dept. of Orthopedics, T.S. Misra Medical College and Hospital, Lucknow, UP, India⁴Assistant Professor, Dept. of Orthopedics, T.S. Misra Medical College and Hospital, Lucknow, UP, India

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Abstract:

Background: Anterior cruciate ligament (ACL) injury is one of the most common ligamentous injuries of the knee, particularly among young and physically active individuals. Although arthroscopic ACL reconstruction is considered the gold standard for restoring knee stability, the optimal timing of surgical intervention remains controversial. Delaying surgery may increase the risk of secondary meniscal injuries due to recurrent instability, whereas very early reconstruction has historically been associated with postoperative arthrofibrosis and knee stiffness. Recent advances in rehabilitation protocols have challenged this concept, emphasizing early restoration of knee motion before surgery. This study aimed to compare early and delayed arthroscopic ACL reconstruction regarding meniscal injury rates, postoperative stiffness, and functional outcomes.

Objectives: To compare the effect of early (≤ 3 weeks) versus delayed (>6 weeks) arthroscopic ACL reconstruction on meniscal injury rates, postoperative stiffness, and functional outcomes.

Materials and Methods: A retrospective comparative study was conducted among 100 patients diagnosed with acute ACL rupture who underwent arthroscopic ACL reconstruction. Fifty patients underwent surgery within three weeks of injury (early group), while fifty underwent surgery after six weeks (delayed group). Patient demographics, meniscal injuries identified during arthroscopy, postoperative knee stiffness, and functional outcomes using the International Knee Documentation Committee (IKDC), Lysholm Knee Score, and Tegner Activity Scale were evaluated during follow-up. Statistical analysis was performed using appropriate parametric and non-parametric tests with $p < 0.05$ considered statistically significant.

Results: The delayed reconstruction group demonstrated a significantly higher incidence of meniscal injuries compared with the early intervention group. Medial meniscal tears were more frequent among delayed cases. The incidence of postoperative knee stiffness was comparable between the two groups following standardized rehabilitation. Functional outcome scores showed significant improvement in both groups, with superior knee stability and patient-reported outcomes observed in the early intervention group.

Conclusion: Early arthroscopic ACL reconstruction performed within three weeks of injury appears to reduce secondary meniscal injuries without increasing postoperative stiffness when combined with appropriate rehabilitation. Early intervention may therefore provide better preservation of intra-articular structures and improved functional recovery.

Keywords: Anterior Cruciate Ligament, Arthroscopy, ACL Reconstruction, Meniscal Tear, Knee Stiffness, Early Surgery, Delayed Surgery.

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Introduction

Anterior cruciate ligament (ACL) rupture is among the most frequently encountered sports-related knee injuries and represents a major cause of instability, functional impairment, and early degenerative joint disease. The incidence of ACL injury has increased globally due to greater participation in competitive sports, recreational activities, and road traffic trauma among young adults. Approximately 200,000 ACL injuries occur annually in the United States, with

nearly half requiring surgical reconstruction to restore knee stability and permit return to sporting activities [1,2].

The ACL serves as the primary restraint against anterior translation of the tibia relative to the femur while also contributing substantially to rotational stability of the knee joint. Loss of ACL integrity results in recurrent episodes of instability, altered

knee biomechanics, increased cartilage loading, and progressive intra-articular damage. Persistent instability may predispose patients to secondary meniscal tears, chondral injuries, and ultimately premature osteoarthritis [3,4].

Arthroscopic ACL reconstruction has become the gold standard treatment for symptomatic ACL-deficient knees, providing reliable restoration of joint stability and enabling patients to resume pre-injury activity levels. Continuous improvements in arthroscopic instrumentation, anatomical graft placement, fixation devices, and accelerated rehabilitation protocols have markedly enhanced postoperative outcomes during the past two decades [5].

Despite advances in surgical techniques, the ideal timing of ACL reconstruction remains controversial. Traditionally, delayed surgery was recommended because early reconstruction performed during the inflammatory phase following injury was believed to increase the incidence of arthrofibrosis, restricted knee motion, postoperative pain, and prolonged rehabilitation [6]. Consequently, many surgeons preferred postponing reconstruction until pain subsided and full range of motion was restored.

However, delaying surgery has important disadvantages. Recurrent episodes of knee instability during daily activities or sports may expose the menisci and articular cartilage to repetitive mechanical stress, thereby increasing the likelihood of secondary intra-articular injuries. Numerous studies have demonstrated a progressive increase in medial meniscal tears and cartilage degeneration as the interval between injury and reconstruction lengthens [7–9].

The medial meniscus functions as a secondary stabilizer in ACL-deficient knees. Continued instability increases compressive and shear forces on the posterior horn of the medial meniscus, making it particularly susceptible to injury. Secondary meniscal tears substantially worsen long-term prognosis because meniscal preservation is strongly associated with improved knee biomechanics and reduced incidence of osteoarthritis [10].

Recent evidence suggests that early arthroscopic reconstruction performed after adequate control of swelling and restoration of knee motion does not necessarily increase postoperative stiffness. Modern rehabilitation emphasizing immediate range-of-motion exercises, quadriceps strengthening, and early weight bearing has significantly reduced the incidence of arthrofibrosis compared with historical series [11,12]. Consequently, the traditional rationale for delaying ACL reconstruction has been questioned.

Several systematic reviews and randomized clinical trials have compared early and delayed ACL

reconstruction; however, the results remain inconsistent. While many investigators have reported lower meniscal injury rates following early intervention, others found no clinically meaningful differences in postoperative stiffness or functional recovery when standardized rehabilitation protocols were implemented [13–16]. Variations in study design, definitions of "early" surgery, surgical techniques, rehabilitation protocols, and follow-up duration have contributed to these discrepancies.

Patient-reported outcome measures such as the International Knee Documentation Committee (IKDC) score, Lysholm Knee Score, and Tegner Activity Scale have become essential tools for evaluating functional recovery following ACL reconstruction. These validated instruments provide comprehensive assessment of pain, symptoms, stability, sports participation, and overall quality of life [17,18].

Understanding the optimal timing of ACL reconstruction is clinically important because it influences surgical planning, rehabilitation strategies, healthcare costs, return-to-sport timelines, and long-term joint preservation. Identifying whether early reconstruction reduces secondary meniscal injuries without increasing postoperative stiffness may assist orthopedic surgeons in optimizing treatment protocols and improving patient outcomes.

Aim of the Study: To compare early (≤ 3 weeks) and delayed (> 6 weeks) arthroscopic ACL reconstruction regarding meniscal injury rates, postoperative knee stiffness, and functional outcomes.

Objectives

1. To compare the incidence of medial and lateral meniscal injuries between early and delayed ACL reconstruction.
2. To evaluate postoperative knee stiffness following arthroscopic ACL reconstruction.
3. To compare functional outcomes using IKDC, Lysholm Knee Score, and Tegner Activity Scale.
4. To determine whether early arthroscopic intervention provides superior clinical outcomes compared with delayed reconstruction.

Materials and Methods

Study Design: A retrospective comparative observational study was conducted to evaluate the clinical outcomes of early versus delayed arthroscopic anterior cruciate ligament (ACL) reconstruction in patients with acute ACL injuries. The study compared the incidence of associated meniscal injuries, postoperative knee stiffness, and functional outcomes following arthroscopic

reconstruction.

Study Setting: The study was conducted in the Department of Orthopaedics at out tertiary care hospital over a study period from January 2022 to December 2024.

Sample Size: A total of 100 patients diagnosed with acute ACL rupture who underwent primary arthroscopic ACL reconstruction were included.

Patients were divided into two groups:

- **Group A (Early Reconstruction):** 50 patients undergoing ACL reconstruction within 3 weeks of injury.
- **Group B (Delayed Reconstruction):** 50 patients undergoing ACL reconstruction after 6 weeks of injury.

The sample size was determined based on the availability of eligible patients during the study period.

Inclusion Criteria: Patients fulfilling all the following criteria were included:

- Age between 18 and 45 years
- MRI-confirmed complete ACL rupture
- Acute ACL injury
- Primary arthroscopic ACL reconstruction
- Unilateral ACL injury
- Minimum follow-up of 12 months
- Ability to participate in postoperative rehabilitation
- Written informed consent

Exclusion Criteria

Patients with any of the following conditions were excluded:

- Previous surgery on the affected knee
- Revision ACL reconstruction
- Multiligament knee injuries
- Associated fractures around the knee
- Chronic ACL injury (>12 months)
- Severe osteoarthritis (Kellgren-Lawrence Grade III or IV)
- Neuromuscular disorders
- Inflammatory arthritis
- Incomplete medical records
- Follow-up less than 12 months

Preoperative Assessment: All patients underwent a comprehensive preoperative evaluation, including detailed history taking, mechanism of injury, interval between injury and surgery, and clinical examination. Knee stability was assessed using the Lachman test, pivot shift test, anterior drawer test, and range of motion assessment. Radiological evaluation included plain radiographs and magnetic resonance imaging (MRI) to confirm ACL rupture and identify associated injuries such as medial or

lateral meniscal tears, chondral lesions, and bone bruises. Baseline demographic data, including age, sex, body mass index (BMI), affected side, occupation, and mechanism of injury, were recorded.

Surgical Technique: All arthroscopic ACL reconstructions were performed by experienced orthopedic surgeons using a standardized technique. Under spinal or combined spinal-epidural anaesthesia, patients were positioned supine with the knee flexed to 90°. Standard anteromedial and anterolateral portals were established for diagnostic arthroscopy to assess the ACL tear, menisci, articular cartilage, posterior cruciate ligament, and synovium. Associated meniscal injuries were managed by meniscal repair, partial meniscectomy, or debridement depending on tear morphology. A quadrupled ipsilateral hamstring autograft (semitendinosus with or without gracilis) was harvested and fixed anatomically using an Endobutton on the femoral side and a bioabsorbable interference screw on the tibial side after appropriate graft tensioning.

Postoperative Rehabilitation: All patients followed a standardized rehabilitation protocol supervised by physiotherapists. Early rehabilitation emphasized pain control, cryotherapy, quadriceps strengthening, ankle pump exercises, straight-leg raising, and gradual restoration of knee range of motion. Progressive strengthening, balance training, proprioceptive exercises, and sport-specific rehabilitation were introduced in subsequent phases. Return to sports was permitted between 9 and 12 months after surgery following restoration of knee stability, functional recovery, and quadriceps strength exceeding 90% of the contralateral limb.

Outcome Measures: The primary outcome was the incidence of associated meniscal injuries, including medial, lateral, and combined meniscal tears identified during arthroscopy. Secondary outcomes included postoperative knee stiffness, defined as an extension deficit greater than 5° or knee flexion less than 120° at three months postoperatively. Functional outcomes were evaluated using the International Knee Documentation Committee (IKDC) score, Lysholm Knee Score, and Tegner Activity Scale at each follow-up visit.

Follow-up: Patients were reviewed at 2 weeks, 6 weeks, 3 months, 6 months, and 12 months after surgery. Each follow-up included clinical examination, assessment of knee range of motion and stability, functional outcome scoring, and documentation of postoperative complications.

Data Collection: Data collected included demographic characteristics (age, sex, BMI, affected side, and mechanism of injury), clinical variables (time from injury to surgery, meniscal and chondral

injuries, operative time, and hospital stay), functional outcome scores (IKDC, Lysholm, Tegner, and knee range of motion), and postoperative complications such as infection, arthrofibrosis, graft failure, reoperation, and knee stiffness.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed

as mean $\pm$ standard deviation (SD), while categorical variables were presented as frequencies and percentages. Comparisons between the early and delayed reconstruction groups were performed using the independent Student's t-test or Mann–Whitney U test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables. A p-value of <0.05 was considered statistically significant.

Results

Table 1: Baseline Demographic and Clinical Characteristics

Variable	Early Reconstruction (n=50)	Delayed Reconstruction (n=50)	p-value
Age (years)	27.8 $\pm$ 6.3	28.6 $\pm$ 6.8	0.54
Male, n (%)	39 (78.0)	37 (74.0)	0.64
Female, n (%)	11 (22.0)	13 (26.0)	
BMI (kg/m ²)	24.3 $\pm$ 2.7	24.8 $\pm$ 2.9	0.39
Right knee involved, n (%)	31 (62.0)	29 (58.0)	0.68
Sports injury, n (%)	30 (60.0)	28 (56.0)	0.68
Road traffic accident, n (%)	14 (28.0)	15 (30.0)	
Fall/Twist injury, n (%)	6 (12.0)	7 (14.0)	

Table 2: Arthroscopic Meniscal Injuries

Meniscal Injury	Early (n=50)	Delayed (n=50)	p-value
No meniscal injury	29 (58.0%)	16 (32.0%)	0.008*
Medial meniscus tear	12 (24.0%)	22 (44.0%)	0.031*
Lateral meniscus tear	7 (14.0%)	8 (16.0%)	0.78
Both menisci injured	2 (4.0%)	4 (8.0%)	0.40

Table 3: Postoperative Knee Stiffness and Complications

Outcome	Early (n=50)	Delayed (n=50)	p-value
Knee stiffness	3 (6.0%)	4 (8.0%)	0.69
Arthrofibrosis	1 (2.0%)	2 (4.0%)	0.56
Superficial infection	1 (2.0%)	1 (2.0%)	1.00
Graft failure	1 (2.0%)	2 (4.0%)	0.56
Reoperation	1 (2.0%)	2 (4.0%)	0.56

Table 4: Functional Outcome Scores at 12 Months

Functional Score	Early	Delayed	p-value
IKDC Score	90.8 $\pm$ 5.2	86.5 $\pm$ 6.1	$<0.001^*$
Lysholm Score	93.6 $\pm$ 4.8	89.4 $\pm$ 5.6	$<0.001^*$
Tegner Activity Score	6.8 $\pm$ 1.1	6.1 $\pm$ 1.2	0.003*

Table 5: Overall Clinical Outcome

Clinical Outcome	Early (n=50)	Delayed (n=50)	p-value
Excellent	34 (68.0%)	23 (46.0%)	0.021*
Good	12 (24.0%)	18 (36.0%)	
Fair	3 (6.0%)	7 (14.0%)	
Poor	1 (2.0%)	2 (4.0%)	

Discussion

The present study compared the clinical outcomes of early (≤ 3 weeks) and delayed (> 6 weeks) arthroscopic anterior cruciate ligament reconstruction in patients with acute ACL injuries. The principal findings demonstrated that early reconstruction significantly reduced the incidence of

secondary meniscal injuries while providing superior functional outcomes without increasing postoperative knee stiffness. These findings support the growing evidence favoring early surgical stabilization of ACL-deficient knees when adequate preoperative rehabilitation has been achieved.

Baseline demographic characteristics were

comparable between the two groups, minimizing potential confounding factors and strengthening the validity of the comparison. Similar age distribution, sex ratio, BMI, and mechanism of injury suggest that the observed differences in outcomes were primarily attributable to the timing of reconstruction rather than patient-related variables.

A major finding of the present study was the significantly higher incidence of medial meniscal tears in the delayed reconstruction group. Persistent instability in ACL-deficient knees exposes the medial meniscus to repetitive shear and rotational forces, predisposing it to secondary injury. The medial meniscus functions as an important secondary stabilizer, particularly in chronically unstable knees, explaining its greater vulnerability. Similar observations have been reported in previous studies demonstrating progressive meniscal damage with increasing delay before ACL reconstruction.

Historically, early ACL reconstruction was believed to increase the risk of postoperative arthrofibrosis and restricted knee motion. However, in the present study, postoperative knee stiffness occurred infrequently and did not differ significantly between groups. Modern rehabilitation emphasizing restoration of range of motion before surgery, early mobilization, quadriceps strengthening, and structured physiotherapy has substantially reduced the risk of arthrofibrosis. These findings are consistent with contemporary literature showing that appropriately selected patients can safely undergo early reconstruction without compromising postoperative mobility.

Functional outcomes measured using IKDC, Lysholm, and Tegner scores were significantly better in the early reconstruction group. Early restoration of knee stability likely prevented recurrent instability episodes, minimized secondary intra-articular damage, and facilitated more effective rehabilitation. Preservation of meniscal integrity may also have contributed to superior knee function and earlier return to pre-injury activity levels.

The findings of the present study have important clinical implications. Early arthroscopic ACL reconstruction may reduce secondary meniscal damage, preserve knee biomechanics, improve functional recovery, and potentially decrease the long-term risk of osteoarthritis. These benefits were achieved without increasing postoperative stiffness when standardized rehabilitation protocols were implemented.

The study has several limitations. It was retrospective in design, conducted at a single center, and included a relatively modest sample size. Follow-up was limited to one year, precluding assessment of long-term osteoarthritis and graft survival. Future multicenter prospective randomized

studies with longer follow-up are recommended to further validate these findings.

Conclusion

Early arthroscopic ACL reconstruction performed within three weeks of injury significantly reduced the incidence of secondary meniscal injuries, particularly medial meniscal tears, compared with delayed reconstruction. Early intervention was not associated with an increased risk of postoperative knee stiffness when combined with standardized rehabilitation protocols. Furthermore, patients undergoing early reconstruction achieved significantly better functional outcomes as demonstrated by higher IKDC, Lysholm, and Tegner scores. These findings support early arthroscopic ACL reconstruction as an effective strategy for preserving intra-articular structures, restoring knee stability, and optimizing functional recovery following acute ACL injury.

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