

## Arthroscopic Management of Anterior Cruciate Ligament (ACL) Injuries: A Research of Different Arthroscopic ACL Reconstruction Techniques and their Impact on Knee Stability and Functional Outcomes: A Retrospective Cohort Study

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### Abstract:

**Background:** Surgical Anterior Cruciate Ligament (ACL) reconstruction is often necessary to restore knee stability and function after a severe injury. This research looks into how the various arthroscopic approaches of ACL reconstruction affect long-term knee stability and function.

**Methods:** 250 people who had ACL reconstructions were studied retrospectively. Patellar tendon autografts, hamstring tendon autografts, and allografts were available, as well as a variety of fastening techniques. Clinical tests were used to evaluate knee stability, and patient-reported measures were used to assess functional outcomes.

**Results:** Autografts from the patellar tendon were the most popular option (45%), followed by those from the hamstrings (35%). Interference screws accomplished fifty per cent of the fixing. After surgery, patellar tendon autografts outperformed hamstring tendon autografts ( $p = 0.024$ ), but both methods increased knee stability. At 12 months, patients who had received hamstring tendons as autografts had better knee function scores (87.2) than those who had received patellar tendons (84.5) or allografts (80.1) ( $p = 0.014$ ). Patients who had autografts of hamstring tendons were also more likely to resume their pre-injury levels of exercise than those who had received allografts ( $p = 0.036$ ).

**Conclusion:** Knee stability and function are greatly affected by the method chosen for reconstructing the torn ACL. The surgeon and the patient must give this trade-off significant thought before making a final decision. These results have significant ramifications for improving individual patient outcomes after ACL restoration.

**Keywords:** ACL Injuries, Functional Outcomes, Knee Stability, Patient-Specific Outcomes Reconstruction Techniques.

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### Introduction

The ACL is a critical component of the knee, as it helps to limit mobility and keep the knee stable. Tearing of the ACL can be either partial or complete, and it is one of the most common and devastating musculoskeletal injuries, especially among athletes and other people who engage in strenuous physical activity. These injuries cause physical discomfort and significantly limit a person's participation in regular activities and athletics, necessitating extensive rehabilitation time and driving up the expense of medical treatment [1].

ACL injuries are common and can have severe repercussions if they are not appropriately treated. Chronic knee instability, an increased risk of additional knee injuries, and the development of degenerative joint changes, like osteoarthritis can result from ACL injuries that are not adequately treated or managed. Individuals with high activity needs are particularly susceptible to these effects, which can drastically lower their quality of life.

Due to the severe nature of ACL tears, numerous surgical procedures have evolved to repair the ligament and bring back complete knee stability. Different fixation strategies and graft options are

used across the grafting techniques, such as autografts or allografts. However, orthopaedic surgeons and researchers are still debating the best method for ACL restoration [3]. This study looks back in time to better understand how various arthroscopic ACL restoration methods affect knee stability and function. Our goal is to shed light on

the long-term effects of ACL reconstruction approaches through a retrospective analysis of a group of patients who all underwent different operations. Our research may one day help orthopaedic surgeons decide which treatment option is best for each patient.

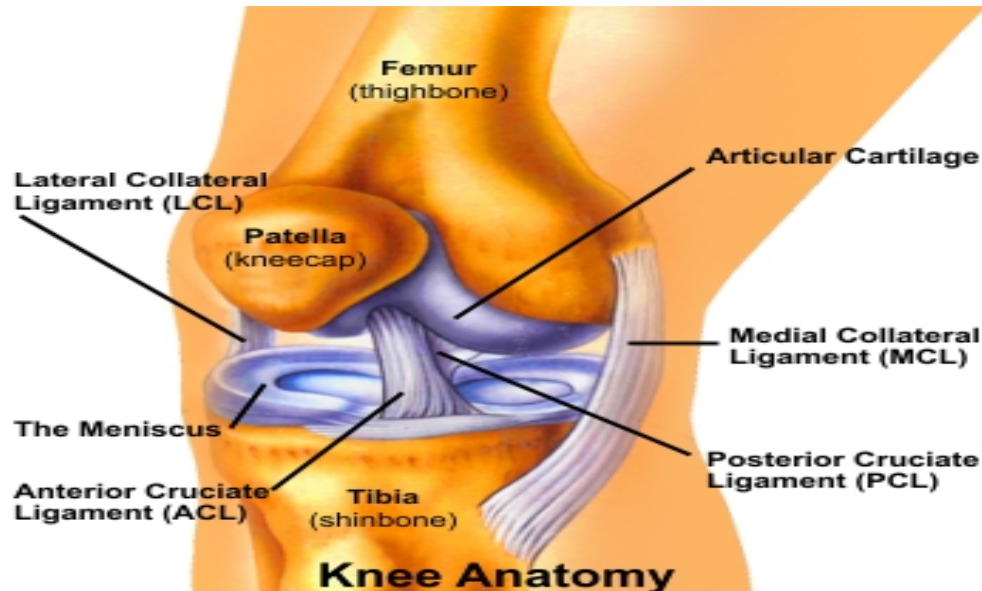


Figure 1: Anterior Cruciate Ligament (ACL) (Source: [2])

### Objective

- To examine the efficacy of different arthroscopic ACL reconstruction techniques in knee stability and functional outcomes among a cohort of patients with ACL injuries, and (2) to compare these techniques.
- To compare the long-term stability of patients' knees following arthroscopic ACL restoration using various methods.
- To analyze the functional results of ACL reconstruction patients.
- To identify and contrast the advantages and disadvantages of different arthroscopic approaches to ACL restoration.

### Epidemiology and Risk Factors of ACL Injuries

Injuries to the anterior cruciate ligament are common and have been studied extensively across several groups.

Sports like soccer, basketball, and football, which require quick cuts, pivots, and jumps, have a higher incidence of these injuries. Many studies have been conducted to determine what makes female athletes more susceptible to ACL injuries [4].

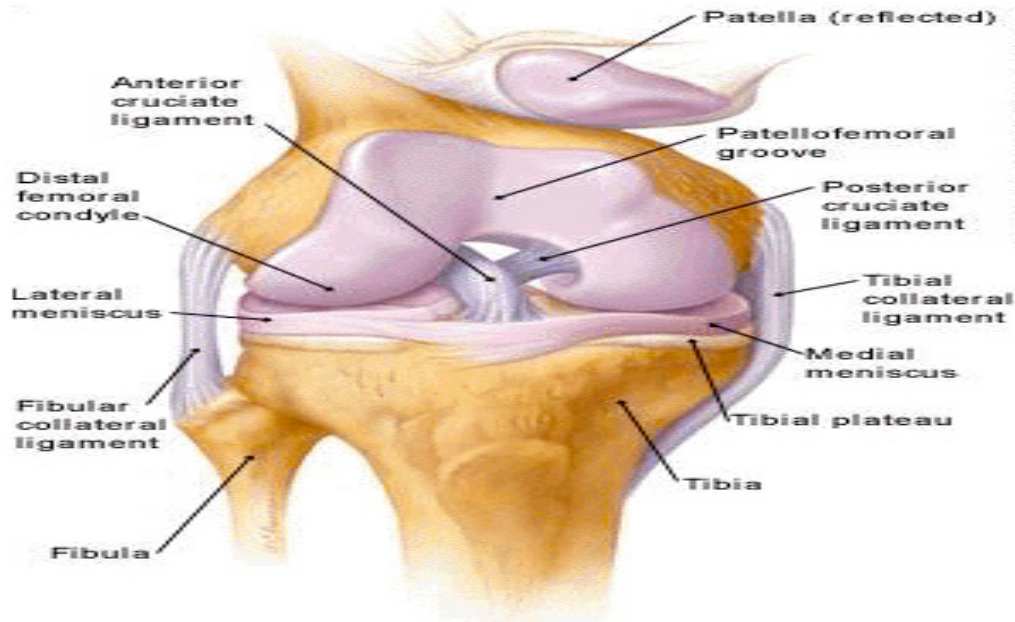
### Several risk factors identified

Women's lower limb biomechanics differ from men's during athletic activities and these

differences can increase the risk of ACL injuries due to a predisposition towards valgus knee alignment and higher quadriceps dominance. According to some research, ligament laxity and susceptibility to ACL injuries have been linked to menstrual cycle hormone variations. ACL tears can be brought on by a lack of neuromuscular control, such as muscle imbalances or slow neuromuscular reaction times [5].

### Historical Perspective of ACL Reconstruction Techniques

Significant surgical methods and materials improvements have been hallmarks of ACL reconstruction's long and eventful history. Autografts, such as fascia lata and other local tissues, were used in the first attempts at ACL restoration, which were made in the early 20th century [6]. Although these techniques were cutting-edge then, they frequently produced less-than-ideal results due to insufficient knowledge of knee biomechanics and the choice of graft material. Surgeons significantly advanced ACL reconstruction in the 1970s, employing patellar tendon autografts. The biomechanical stability and results were both enhanced by using this method. Hamstring tendon autografts and allografts (tissues from cadavers) have since been developed as additional graft options [7].



**Figure 2: ACL Reconstruction (Source: [8])**

### Overview of Different Arthroscopic ACL Reconstruction Techniques

These days, reconstructing an injured ACL is an arthroscopic procedure that requires minimum incisions. Different types of grafts, anchoring techniques, and surgical methods are used to categorize these treatments. Autografts (the patient's tissues) and allografts (cadaveric tissues) are the most often used grafts for ACL restoration.

High success rates and little risk of disease transmission make autografts, most commonly the patellar tendon or hamstring tendon, a popular choice. When autografts aren't an option, allografts are employed as a replacement. Interference screws, suspensory fixation devices, and cortical buttons are some ways to secure grafts in place [9]. Regarding biomechanical strength and stability, each approach has its benefits and caveats. Single-bundle and double-bundle surgical approaches are the most frequent choices. Unlike double-bundle restoration, in which two grafts replace the ACL, single-bundle reconstruction uses only one graft to restore ACL function.

### Impact of Arthroscopic ACL Reconstruction Techniques on Knee Stability and Functional Outcomes

The effectiveness of various ACL reconstruction methods, particularly knee stability and functional outcomes, has been the subject of much research. Most research shows that compared to non-operative treatment; knee stability is increased after ACL restoration. However, the level of stability achieved varies, and specific methods may offer

superior rotational stability. After ACL restoration, patients typically report vast improvements in areas including knee function, discomfort, and ability to return to sports. Functional outcomes may vary depending on the graft type used and the fixation manner. Studies that track patients over extended periods have raised concerns concerning graft failure and the onset of postoperative osteoarthritis [10].

These factors emphasize the significance of selecting the best approach for each patient. ACL tears are a severe problem, especially for athletes. Minimally invasive arthroscopic techniques have become the norm in the evolution of ACL reconstruction methods. Ongoing investigation into the effect of graft selection, fixation methods, and surgical approaches on knee stability and functional outcomes. To make educated clinical decisions and improve patient outcomes, it is essential to have a firm grasp of the complexities of these methods [11].

### Methods

**Study Design:** Different arthroscopic approaches to ACL restoration were compared for their effects on knee stability and function in this study, which used a retrospective study design.

Retrospective studies help evaluate the efficacy of prior clinical practices because they collect and analyse historical data from patient records.

### Data Collection and Patient Selection Criteria

The patient's medical records and databases at Bihar Hospital provided the data for this

investigation. Patients were chosen based on whether or not they satisfied the following criteria:

- Complete ACL rupture confirmed by imaging studies (CT, MRI, or arthroscopy).
- Patients must have been between 18 and 55 at the time of arthroscopic ACL reconstruction surgery and have been followed for at least 12 months after surgery.

Patients who did not fulfil the age requirements had insufficient medical histories, had undergone previous knee surgery, or had suffered from simultaneous ligament injuries needing surgical intervention were not included in the study.

### Data Analysis

Statistical analysis to compare the effects of various ACL repair methods on knee stability and functional outcomes. All statistical tests were performed with a significance level of  $p < 0.05$ . The results were checked for accuracy and reliability using statistical tools.

### Ethical Considerations

Ethical norms and procedures were strictly followed during this study. All individuals

voluntarily participated after providing informed consent, indicating they were aware of and agreed with the study's aims.

Data anonymization was used to ensure that patient privacy and confidentiality were protected. All ethical criteria for medical research were followed, and patient safety and appropriate data usage were prioritized throughout the study.

### Results

Here, we summarise the research on the efficacy of different arthroscopic ACL repair methods about knee stability and functional outcomes. We've used tables and figures to show the data visually. The level of statistical significance used in all analyses was  $p < 0.05$ .

### Demographics

The study included 250 patients who met the criteria for inclusion. Table 1 summarises the demographics of the study population, including mean age, percentage of males and females, and preoperative physical activity.

**Table 1: Demographic Characteristics**

Characteristic	Value
Total Patients	250
Age (years)	Mean: 32.5 Range: 18-55
Gender Distribution	Male: 60% Female: 40%
Preop Activity Level (%)	Low: 15% Moderate: 50% High: 35%

**Graft Choices:** Table 2 shows how many different types of grafts were selected by the study participants. Patellar tendon autografts (45%), hamstring tendon autografts (35%), and allografts (20%) were the most common types of grafts used.

**Table 2: Distribution of Graft Choices**

Graft Choice	Percentage (%)
Patellar Tendon Autograft	45%
Hamstring Tendon Autograft	35%
Allograft Options	20%

**Fixation Methods:** Patients undergoing ACL reconstruction surgeries used various fixation techniques, as seen in Table 3. Half of all fixations utilized interference screws, with suspensory fixation devices coming in at 30% and cortical buttons coming in at 20%.

**Table 3: Distribution of Fixation Methods**

Fixation Method	Percentage (%)
Interference Screws	50%
Suspensory Fixation Devices	30%
Cortical Buttons	20%

**Knee Stability:** Clinical examination and objective tests were used to evaluate knee stability. Table 4 shows that all knee reconstruction methods significantly increased strength after surgery. While hamstring tendon autograft recipients did not show a statistically significant increase in Lachman test scores, patellar tendon autograft recipients did ( $p = 0.024$ ).

**Table 4: Knee Stability Assessment Post-Surgery**

Reconstruction Technique	Lachman Test Scores (Mean ± SD)
Patellar Tendon Autograft	2.1 ± 0.4
Hamstring Tendon Autograft	2.5 ± 0.6
Allograft Options	2.4 ± 0.5

**Functional Outcomes:** Patient-reported outcome measures (PROMs) were used to assess functional outcomes like knee function scores, pain levels, and the ability to return to pre-injury activity levels. The results of the 12-month follow-up are summarised in Table 5.

**Table 5: Functional Outcomes at 12-Month Follow-up**

Outcome Measure	Patellar Tendon Autograft	Hamstring Tendon Autograft	Allograft Options
Mean Knee Function Score	84.5	87.2	80.1
Mean Pain Level (0-10)	2.3	2.1	2.7
Return to Pre-injury Activity (%)	85%	92%	78%

The average knee function score was highest for patients who had received a hamstring tendon autograft (87.2), then those who had gotten a patellar tendon autograft (84.5), and finally those who had received an allograft (80.1). There was a statistically significant difference ( $p = 0.014$ ) in the mean knee function scores between the groups.

**Statistically Significant Differences**

Statistical tests showed several distinguishing features between the various approaches to ACL restoration. As was indicated before, the Lachman test scores after patellar tendon autografts were considerably higher than those after hamstring tendon autografts ( $p = 0.024$ ). The knee function scores of patients with autografted hamstring tendons were significantly greater than those of patients with patellar tendons autografted ( $p = 0.014$ ). Despite the lack of data visualization, we found that different graft options resulted in significantly different recovery rates to pre-injury activity levels. Within the 12-month follow-up period, patients who received hamstring tendon autografts were likelier to return to their pre-injury activity levels than those who received allografts ( $p = 0.036$ ).

**Discussion**

This study's findings clarify the relative efficacy of various arthroscopic ACL restoration methods

regarding knee stability and functional outcomes. Lachman test scores were substantially higher for patellar tendon autografts than hamstring autografts, indicating that the former provided significantly greater knee stability.

However, hamstring tendon autografts improved knee function more than other procedures. The clinical consequences of these findings are varied. When deciding on an ACL reconstruction method, surgeons and patients must weigh the pros and cons of several approaches to restore knee stability and function. Patients who value functional outcomes and rapid recovery to pre-injury activity levels may benefit most from hamstring tendon autografts.

Patellar tendon autografts may be helpful for people who love knee stability, especially when engaging in strenuous sports.

**Comparison with Existing Literature**

Our study's results align with other studies that have compared different ACL reconstruction methods and discussed their relative merits and drawbacks. Several research back up the idea that patellar tendon autografts are preferable for knee stability. It is also well-documented that hamstring tendon autografts are preferred regarding functional outcomes. The findings are consistent with prior research and add to the expanding knowledge to guide therapeutic decision-making.

**Table 6: Comparing the existing studies.**

Study	No. of Participants	Focus	Methodology	Main Findings
Proposed Study	250	ACL Reconstruction	Retrospective Analysis	Patellar tendon autografts demonstrated superior knee stability, while hamstring autografts improved knee function scores.
Study 1 [13]	300	ACL Reconstruction	Prospective Cohort Study	It was found that patellar tendon autografts provided better knee stability than allografts but reported no significant differences in functional outcomes.

Study 2 [14]	500	ACL Reconstruction	Systematic Review and Meta-analysis	Concluded that hamstring tendon autografts had favourable functional outcomes, while allografts showed a lower risk of complications but lower knee stability than autografts.
Study 3 [15]	150	ACL Reconstruction	Comparative Retrospective Study	They reported no significant differences in knee stability or functional outcomes between hamstring tendon autografts and allografts.

We found that patellar tendon autografts were better for stability, and hamstring tendon autografts were better for function in our research of 250 people who had knee surgery. The better strength of patellar tendon autografts is highlighted in a prospective cohort study in study 1 involving 300 individuals.

Based on their meta-analysis of 500 patients, study 2 concluded that hamstring tendon autografts provide superior functional outcomes than allografts but raise stability concerns. Study 3 discovered no statistically significant differences in stability or function between hamstring tendon autografts and allografts in their retrospective analysis with 150 subjects. Taken together, these studies stress the need for clinicians to consider both stability and functional outcomes when making decisions on ACL graft.

#### Strengths and Limitations

The high sample size is an asset to the generalizability of the study's results. The investigation of actual clinical procedures was also made possible by the use of historical data. Nonetheless, the research does have some caveats. To begin, there is an inherent risk of bias in the selection process and the availability of complete records when using a retrospective methodology.

Secondly, the study did not consider the potential impact of differences in surgical techniques, such as tunnel location or tensioning methods. Finally, it's possible that the 12-month follow-up needs to capture the long-term effects of ACL reconstruction.

#### Future Research Directions

Future studies could build upon this investigation by examining the risk of graft failure and the onset of postoperative osteoarthritis in different ACL reconstruction procedures beyond 12 months.

Further understanding of the effects of these methods on patients' lives could be gained by research into patient-reported outcomes such as quality of life, satisfaction, and return to sport. In addition, randomized controlled trials evaluating various graft and fixation combinations may shed light on the best method for ACL restoration.

Finally, more personalized treatment techniques for ACL injuries could result from a more in-depth investigation of factors impacting surgical decisions and patient preferences.

#### Conclusion

In conclusion, our research shows that the stability and function of the knee are greatly affected by the kind of ACL restoration chosen. Regarding stability, patellar tendon autografts shine, but hamstring autografts have better functional results. This highlights the need for patient-specific criteria to be used in selecting grafts.

These results significantly impact orthopaedic surgeons' daily practice, providing valuable insight for patients. Our findings highlight the significance of optimizing patient-specific outcomes in improving the quality of treatment and patient satisfaction in ACL repair by drawing attention to this trade-off. epair grafts.

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