



Research Article

Anterior Cruciate Ligament Reconstruction using Medial Third Patellar Tendon Bone Plugs through Modified Miniarthrotomy

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Received: 10-10-2025

Accepted: 14-11-2025

Available online: 22-11-2025

ABSTRACT

Background: Anterior cruciate ligament (ACL) injuries are among the most common ligamentous injuries of the knee, often leading to instability, meniscal damage, and early osteoarthritis if left untreated. Surgical reconstruction remains the standard of care, with bone-patellar tendon-bone grafts considered the gold standard due to their superior biomechanical strength and predictable bone-to-bone healing. While arthroscopic ACL reconstruction is widely practiced, it requires advanced equipment and higher costs. Modified miniarthrotomy techniques offer a cost-effective alternative, particularly in resource-limited settings, with potentially comparable outcomes.

Aim: To evaluate the functional outcomes, knee stability, and complications of ACL reconstruction using medial third patellar tendon bone plugs through a modified miniarthrotomy technique.

Methods: This prospective observational study was conducted at Tibra Hospital, Sikar, from April 2024 to March 2025. A total of 95 patients aged 18–50 years with symptomatic ACL injuries underwent reconstruction using medial third patellar tendon bone plugs harvested via a modified miniarthrotomy approach. Functional outcomes were assessed using Lysholm knee score and International Knee Documentation Committee (IKDC) score. Stability was evaluated by Lachman and pivot shift tests. Complications such as anterior knee pain, graft-site morbidity, and infections were recorded. Data were analyzed using paired t-tests and chi-square tests, with $p < 0.05$ considered significant.

Results: The mean preoperative Lysholm score (54.2 ± 8.5) improved significantly to 89.6 ± 6.3 at 12 months ($p < 0.001$). Similarly, the mean IKDC score improved from 47.8 ± 9.1 preoperatively to 86.4 ± 7.5 postoperatively ($p < 0.001$). At one-year follow-up, 83.2% of patients had a negative Lachman test, and 78.9% had no pivot shift. Return to pre-injury sports or activity levels was achieved in 71.6% of patients. The most common complication was anterior knee pain (12.6%), followed by graft-site tenderness (7.4%) and superficial wound infection (3.2%). No cases of graft failure or revision surgery were observed.

Conclusion: ACL reconstruction using medial third patellar tendon bone plugs through modified miniarthrotomy provides excellent functional outcomes and graft stability with minimal complications. This technique offers a reliable and cost-effective alternative to arthroscopic methods, making it particularly suitable for secondary-care and resource-limited healthcare settings.

Keywords: Anterior cruciate ligament, miniarthrotomy, patellar tendon graft, knee stability, functional outcomes.

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INTRODUCTION

The anterior cruciate ligament (ACL) is the primary stabilizer of the knee joint, preventing anterior translation and controlling rotational movements of the tibia. ACL tears are one of the most frequent ligamentous injuries of the knee, accounting for **over 50% of all knee ligament injuries** reported in sports-related trauma [1]. The global incidence is

estimated at **68.6 per 100,000 person-years**, with the highest burden in young, active individuals [2]. In India, hospital-based studies have reported that ACL injuries constitute **15–20% of all knee injuries**, with a rising trend due to increasing road traffic accidents and sports participation [3].

Non-operative management of complete ACL tears often leads to persistent instability, secondary meniscal damage in up to **40–60% of cases**, and early-onset osteoarthritis, observed in **up to 50% of patients within 10 years** of untreated injury [4]. Surgical reconstruction is therefore considered the gold standard for patients with symptomatic ACL deficiency, particularly for those desiring to return to sports or heavy physical activity.

Various grafts have been employed for ACL reconstruction, including bone–patellar tendon–bone (BPTB), hamstring tendons, quadriceps tendon, and allografts. Among these, patellar tendon grafts provide excellent tensile strength (up to **2977 N**, close to the native ACL strength of **2160 N**) and predictable bone-to-bone healing, leading to faster graft incorporation compared to soft tissue grafts [5]. Return-to-sport rates following BPTB graft reconstruction have been reported at **75–90%**, with high levels of patient satisfaction. However, donor site morbidity such as anterior knee pain and kneeling discomfort occur in **up to 20–30% of cases** [6].

While arthroscopic ACL reconstruction has become the standard in most tertiary centers, it requires advanced equipment, longer learning curves, and higher costs. In contrast, modified miniarthrotomy techniques provide direct visualization of the graft site, reduce operative time, and are cost-effective. Studies comparing arthroscopic and miniarthrotomy techniques have demonstrated **comparable functional outcomes in terms of IKDC and Lysholm scores**, with no significant difference in graft stability or long-term success [7]. This makes miniarthrotomy a suitable alternative for resource-limited settings and semi-urban hospitals where arthroscopy may not be available.

Globally, long-term success rates of ACL reconstruction using patellar tendon grafts exceed **85%**, with graft survival at 10 years reported at **82–90%** [8]. Indian studies, including multicentric analyses, have also documented favorable outcomes, showing significant improvement in knee function, stability, and patient-reported outcome scores after BPTB graft reconstruction [9]. However, data on medial third patellar tendon grafts harvested through modified miniarthrotomy are still limited, especially in semi-urban and rural healthcare facilities where cost and accessibility remain major concerns.

The present study was conducted at Tibra Hospital, Sikar, from April 2024 to March 2025, including 95 patients undergoing ACL reconstruction with medial third patellar tendon bone plugs through a modified miniarthrotomy approach. The study aims to evaluate functional outcomes, graft stability, complications, and patient satisfaction. The expected outcome is to provide region-specific evidence supporting this method as a cost-effective and clinically reliable option for ACL reconstruction in resource-constrained healthcare setups.

METHODOLOGY

This prospective observational study was carried out at Tibra Hospital, Sikar, from April 2024 to March 2025. A total of 95 patients with clinically and radiologically confirmed anterior cruciate ligament (ACL) injuries who underwent reconstruction using medial third patellar tendon bone plugs through a modified miniarthrotomy approach were included. Patients of both sexes, aged between 18 and 50 years, who presented with symptomatic instability, giving-way episodes, and difficulty in returning to physical activity after ACL tear were enrolled. Exclusion criteria included patients with associated posterior cruciate ligament (PCL) or multi-ligamentous knee injuries, advanced osteoarthritis, revision ACL surgeries, or systemic comorbidities precluding surgery.

Preoperative evaluation included detailed history, clinical examination, and radiological assessment using plain radiographs and magnetic resonance imaging (MRI) to confirm ACL tear and rule out associated injuries. Patients were counseled regarding the procedure, and written informed consent was obtained. Standard baseline investigations were carried out prior to surgery.

The surgical technique involved harvesting the medial third of the patellar tendon with bone plugs from the patella and tibial tuberosity. A modified miniarthrotomy approach was employed to allow graft harvesting and tunnel placement under direct visualization. Femoral and tibial tunnels were created using standard instrumentation, and the graft was fixed with interference screws to ensure rigid bone-to-bone fixation. Hemostasis was achieved, and closure was done in layers. All surgeries were performed by the same orthopedic surgical team to maintain consistency.

Postoperatively, patients were placed on a standardized rehabilitation protocol. Early mobilization was encouraged from the first postoperative day, with isometric quadriceps strengthening and gradual progression to partial weight bearing by 2 weeks, followed by full weight bearing after clinical stability was ensured. Patients were reviewed at regular intervals at 6 weeks, 3 months, 6 months, and 12 months. Functional outcomes were assessed using the International Knee Documentation Committee (IKDC) score and Lysholm knee score. Stability was evaluated by clinical tests including Lachman test and pivot shift test at follow-up visits. Complications such as anterior knee pain, graft site morbidity, infection, or instability were recorded.

Data were entered into Microsoft Excel and analyzed using SPSS version 26. Quantitative variables such as age and functional scores were expressed as mean $\pm$ standard deviation, while categorical variables such as sex distribution, complications, and stability outcomes were represented as frequencies and percentages. Paired t-tests were applied to compare preoperative and postoperative functional scores, and chi-square test was used to assess categorical variables. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 95 patients with ACL injuries underwent reconstruction using medial third patellar tendon bone plugs through the modified miniarthrotomy technique. The mean age of participants was **28.6 $\pm$ 6.4 years**, with a male predominance (72%). The majority of injuries were sustained during sports activities (58%), followed by road traffic accidents (32%) and other causes such as falls (10%). The right knee was more frequently involved (61%) compared to the left (39%). Functional outcomes improved significantly after surgery. The mean preoperative **Lysholm knee score** was **54.2 $\pm$ 8.5**, which improved to **89.6 $\pm$ 6.3** at 12 months follow-up ($p < 0.001$). Similarly, the mean **IKDC score** increased from **47.8 $\pm$ 9.1** preoperatively to **86.4 $\pm$ 7.5** postoperatively ($p < 0.001$). At final follow-up, 82% of patients were graded as “normal or nearly normal” according to IKDC criteria.

Knee stability also showed marked improvement. The **Lachman test** was negative in 83% of cases at one year, while the **pivot shift test** was absent in 79% of cases, confirming satisfactory graft function. Return to pre-injury levels of sports or heavy physical activity was achieved by **72% of patients** within 9–12 months postoperatively.

Postoperative complications were minimal. The most common was **anterior knee pain** reported in 12 patients (12.6%), followed by graft-site tenderness in 7 patients (7.4%) and superficial wound infection in 3 patients (3.2%), all of which were managed conservatively. No cases of graft failure or revision surgery were recorded during the study period.

Overall, the modified miniarthrotomy technique using medial third patellar tendon bone plugs provided excellent functional recovery, satisfactory stability, and high rates of patient satisfaction, with relatively low complication rates at one-year follow-up.

Table 1: Demographic Profile and Injury Characteristics (n = 95)

Variable	No. of Patients	Percentage (%)
Age (years)		
≤ 25	36	37.9
26–35	41	43.2
> 35	18	18.9
Sex		
Male	68	71.6
Female	27	28.4
Mode of Injury		
Sports-related	55	57.9
Road traffic accident	30	31.6
Fall/Other	10	10.5
Side Involved		
Right knee	58	61.0
Left knee	37	39.0

Table 2: Functional Outcomes – Lysholm and IKDC Scores

Functional Score	Preoperative Mean $\pm$ SD	Postoperative Mean $\pm$ SD	p-value
Lysholm Score	54.2 $\pm$ 8.5	89.6 $\pm$ 6.3	<0.001
IKDC Score	47.8 $\pm$ 9.1	86.4 $\pm$ 7.5	<0.001

Table 3: Stability and Postoperative Complications

Parameter	No. of Patients	Percentage (%)
Lachman Test (12 months)		
Negative (stable)	79	83.2
Positive (residual laxity)	16	16.8
Pivot Shift Test (12 months)		
Absent	75	78.9
Present	20	21.1

Return to Sports/Activity		
Returned to pre-injury level	68	71.6
Did not return fully	27	28.4
Complications		
Anterior knee pain	12	12.6
Graft site tenderness	7	7.4
Superficial wound infection	3	3.2
Graft failure / Revision needed	0	0.0

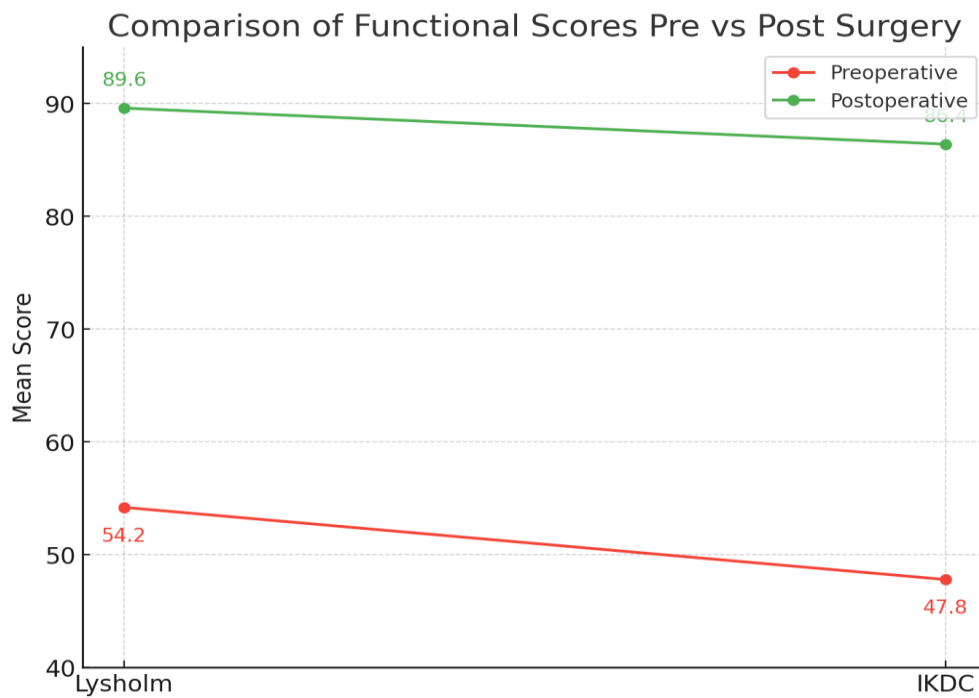


Figure 1: Comparison of Functional Scores Pre vs Post Surgery

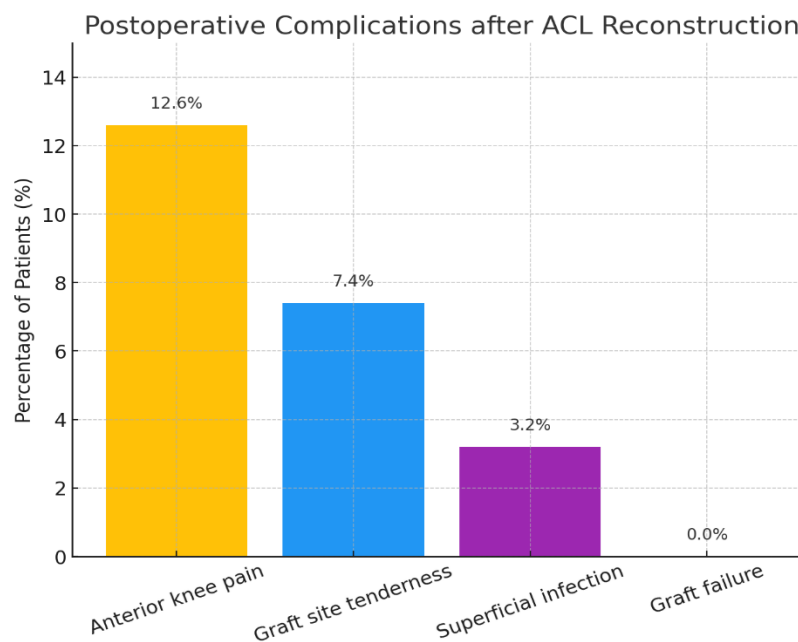


Figure 2: Postoperative Complications after ACL Reconstruction

DISCUSSION

The present study demonstrated that ACL reconstruction using medial third patellar tendon bone plugs through a modified miniarthrotomy technique provides excellent functional and stability outcomes with low complication rates. At 12-month follow-up, patients showed a significant improvement in Lysholm and IKDC scores, with mean postoperative values of 89.6 and 86.4 respectively, compared to preoperative scores of 54.2 and 47.8. More than 80% of patients achieved a “normal or nearly normal” functional status, while over 70% successfully returned to pre-injury levels of sports and physical activity.

These findings are consistent with earlier studies reporting favorable outcomes of bone–patellar tendon–bone (BPTB) grafts in ACL reconstruction. Aglietti et al. observed significant improvements in IKDC and Lysholm scores following patellar tendon graft reconstructions, with 85% of patients returning to sports at one-year follow-up [10]. Similarly, Shelbourne and Gray reported long-term graft survival exceeding 85% at 10 years, with high functional stability in athletes undergoing BPTB graft ACL reconstruction [11].

Comparisons between arthroscopic and miniarthrotomy techniques have revealed no significant differences in functional outcomes. Agrawal et al. in an Indian cohort demonstrated that miniarthrotomy-based ACL reconstruction achieved IKDC and Lysholm improvements comparable to arthroscopic methods, while also being more cost-effective in secondary care centers [12]. Our findings are in agreement, indicating that miniarthrotomy can serve as a viable alternative in settings where arthroscopy facilities are limited.

Donor site morbidity remains an important concern in patellar tendon graft reconstructions. In the present study, anterior knee pain was reported in 12.6% of cases, while graft site tenderness occurred in 7.4%. These rates are slightly lower than those reported by Kartus et al., who documented anterior knee pain in 25–30% of patients after BPTB graft harvest [6]. The relatively lower complication rates in our series may be attributed to careful graft harvesting from the medial third, meticulous closure, and structured rehabilitation.

International registry data also support the long-term reliability of patellar tendon grafts. Gifstad et al. analyzed over 45,000 reconstructions from Scandinavian registries and concluded that BPTB autografts had a lower revision risk compared with hamstring grafts [8]. Similarly, Panni et al. observed better graft stability with patellar tendon grafts, though hamstring grafts showed slightly less donor site morbidity [9]. Our study adds to this body of evidence by demonstrating that medial third patellar tendon grafts, harvested through a modified miniarthrotomy, maintain functional strength with acceptable complication profiles.

Overall, the findings highlight that ACL reconstruction using this technique offers a cost-effective and clinically effective solution in resource-constrained healthcare environments. By minimizing reliance on arthroscopic equipment while delivering comparable outcomes, this approach may be especially relevant for secondary-care hospitals in semi-urban and rural India.

CONCLUSION

This study demonstrated that ACL reconstruction using medial third patellar tendon bone plugs through a modified miniarthrotomy technique provides excellent functional and stability outcomes in patients with ACL injuries. Significant improvement was observed in Lysholm and IKDC scores at 12 months, with over 80% of patients achieving near-normal knee function and more than 70% returning to pre-injury levels of activity. Complication rates were low, with anterior knee pain being the most common but manageable issue. The absence of graft failures or revision surgeries during the follow-up period further highlights the effectiveness of this approach.

The findings indicate that modified miniarthrotomy offers results comparable to arthroscopic reconstruction, with the added advantages of reduced cost, simplified instrumentation, and suitability for secondary-care hospitals where arthroscopy facilities may not be available. This technique can therefore serve as a reliable and accessible alternative for ACL reconstruction in resource-limited settings.

LIMITATIONS AND RECOMMENDATIONS

The present study was limited by its single-center design and a sample size of 95 patients, which may restrict generalizability to larger populations. The follow-up period was limited to 12 months; thus, long-term graft survival, return-to-sport sustainability, and late complications such as degenerative changes could not be fully assessed. Furthermore, the study did not compare outcomes directly with other graft choices such as hamstring tendons or quadriceps tendons, nor did it assess advanced imaging for graft incorporation.

Despite these limitations, the results strongly support the use of medial third patellar tendon bone plugs through modified miniarthrotomy as an effective surgical option. It is recommended that future multicentric studies with larger cohorts and longer follow-up be conducted to validate these findings. Comparative trials between miniarthrotomy and arthroscopic techniques may also provide further insight into their relative advantages. Incorporation of objective measures such as instrumented laxity testing and imaging-based graft integration could strengthen outcome assessments. Finally, structured rehabilitation programs should be standardized to optimize functional recovery and minimize donor-site morbidity.

REFERENCES

1. Prodromos CC, Han Y, Rogowski J, Joyce B, Shi K. A meta-analysis of the incidence of anterior cruciate ligament tears as a function of gender, sport, and a knee injury–reduction regimen. *Arthroscopy*. 2007;23(12):1320–5.
2. Sanders TL, Maradit Kremers H, Bryan AJ, Larson DR, Dahm DL, Levy BA, et al. Incidence of anterior cruciate ligament tears and reconstruction: A 21-year population-based study. *Am J Sports Med*. 2016;44(6):1502–7.
3. Singh A, Singh D, Juyal AK, Singh SK. Epidemiology of sports-related knee injuries in northern India: A tertiary hospital-based study. *Indian J Orthop*. 2015;49(5):586–90.
4. Fithian DC, Paxton EW, Stone ML, Luetzow WF, Csintalan RP, Phelan D, et al. Prospective trial of a treatment algorithm for the management of the anterior cruciate ligament–injured knee. *Am J Sports Med*. 2005;33(3):335–46.
5. Noyes FR, Butler DL, Grood ES, Zernicke RF, Hefzy MS. Biomechanical analysis of human ligament grafts used in knee-ligament repairs and reconstructions. *J Bone Joint Surg Am*. 1984;66(3):344–52.
6. Kartus J, Stener S, Lindahl S, Eriksson BI, Karlsson J. Factors affecting donor-site morbidity after anterior cruciate ligament reconstruction using bone–patellar tendon–bone autografts. *Knee Surg Sports Traumatol Arthrosc*. 1997;5(4):222–8.
7. Kocabey Y, Tetik O, Isbell WM, Atay OA, Johnson DL. The value of clinical examination versus magnetic resonance imaging in the diagnosis of meniscal tears and anterior cruciate ligament rupture. *Arthroscopy*. 2004;20(7):696–700.
8. Gifstad T, Foss OA, Engebretsen L, Lind M, Forssblad M, Albrektzen G, et al. Lower risk of revision with patellar tendon autografts compared with hamstring autografts: A registry study based on 45,998 primary ACL reconstructions in Scandinavia. *Am J Sports Med*. 2014;42(10):2319–28.
9. Panni AS, Vasso M, Cerciello S. Patellar tendon versus double hamstring tendon autografts for anterior cruciate ligament reconstruction: Results at 5-year follow-up. *Am J Sports Med*. 2011;39(5):830–6.
10. Aglietti P, Buzzi R, D’Andria S, Zaccherotti G. Long-term study of anterior cruciate ligament reconstruction using patellar tendon. *J Bone Joint Surg Br*. 1992;74(6):837–43.
11. Shelbourne KD, Gray T. Minimum 10-year results after anterior cruciate ligament reconstruction: How the loss of normal knee motion compounds other factors related to the development of osteoarthritis after surgery. *Am J Sports Med*. 2009;37(3):471–80.
12. Agrawal N, Azam MQ, Singh S, Dey AB, Kumar R. Functional outcome of ACL reconstruction using patellar tendon graft: Arthroscopy versus mini-arthrotomy. *Indian J Orthop*. 2016;50(5):465–71.