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Original Research Article

Clinical outcomes of combined anterior cruciate ligament reconstruction and lateral extra-articular tenodesis in patients with significant pivot shift: a prospective observational study

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ABSTRACT

Background: A high-grade pivot shift is associated with damage to the anterolateral structures of the knee and is a risk factor for ongoing rotational instability following isolated ACL reconstruction. This study aimed to assess the clinical results of combined ACL reconstruction (ACLR) and lateral extra-articular tenodesis (LET) in patients with large pivot shift (PS) at presentation.
Methods: This prospective observational study was carried out at the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR) from July 2021 to June 2025. Forty-five patients with a grade II or III pivot shift who underwent combined ACLR and LET were enrolled and followed to the final follow-up. Functional outcome was assessed using the International Knee Documentation Committee (IKDC) subjective score and Lysholm score, and knee stability was assessed using the pivot-shift and Lachman tests. Data were entered and analyzed on SPSS version 26.
Results: The mean age was 27.8±6.4 years, and the male predominance was 66.7%. The mean IKDC score improved from 51.8±8.7 to 87.6±7.2, and the mean Lysholm score from 55.4±9.5 to 91.2±6.8. At final follow-up, the pivot-shift test was negative in 88.9%, and the Lachman test was negative in 86.7% of patients. The number of giving-way episodes fell from 88.9% to 6.7%, and 80% of patients returned to their pre-injury activity level. Complications were rare, with only one patient developing graft failure (2.2%).
Conclusions: In patients with large pivot shift, combined ACLR and LET resulted in improvement in functional outcome and restored rotatory and anteroposterior knee stability with an acceptable complication rate.

Keywords: Anterior cruciate ligament reconstruction, Lateral extra-articular tenodesis, Pivot shift, Knee instability

INTRODUCTION

The anterior cruciate ligament (ACL) is the most commonly injured major ligament of the knee, and its tear is becoming more common in young, physically active people involved in pivoting and cutting sports.[1] In addition to anteroposterior laxity, a significant number of ACL-deficient knees have a high-grade pivot shift, which indicates that there is a concomitant injury to the anterolateral structures of the knee, such as the

anterolateral ligament and the deep fibers of the iliotibial band.[2] These anterolateral structures are secondary restraints to internal tibial rotation, and their disruption is a cause of continued rotatory instability after an anatomically successful intra-articular ACL reconstruction (ACLR).[3] While isolated ACLR is effective in restoring anteroposterior stability, it often fails to eliminate a residual pivot shift, especially in knees with high-grade preoperative laxity, generalized ligamentous hyperlaxity, or a desire to return to high-demand pivoting sports.[4] This residual rotatory instability has been associated with poorer patient-reported outcomes, a feeling of the knee "giving way," and increased risk of graft failure and revision surgery. This has led to a renewed interest in the use of an additional procedure, usually a lateral extra-articular tenodesis (LET), to control anterolateral rotatory laxity (ALL) in addition to intra-articular ACLR.[5] The addition of LET to ACLR has been shown to meaningfully decrease the rate of clinical failure in young, high-risk patients in Level I evidence from multicenter randomized trials.[6] These results have been confirmed by subsequent meta-analyses of randomized controlled trials, which showed that combined ACLR and LET resulted in significantly better control of the pivot shift and lower failure rates of the graft without a proportional rise in complication rates.[7] Network meta-analyses have also demonstrated that both anterolateral augmentation techniques are superior to isolated ACLR in restoring rotatory stability, and that there are no significant differences between the two augmentation techniques in terms of functional scores.[8] Likewise, systematic reviews have shown that LET combined with ACLR results in decreased knee rotation laxity and graft failure rate, and a recent meta-analysis of the modified Lemaire technique demonstrated better stability restoration with LET combined with ACLR than isolated ACLR, with a lower graft reinjury rate.[9,10] Despite this increasing evidence, the majority of supporting data comes from high-income countries where the majority of patients are young, elite, or recreational athletes, and prospective outcome data for combined ACLR and LET from South Asian tertiary trauma centers is limited. Patients seen at these centers are likely to have a wider age range, delayed presentation, and significant burden of associated meniscal and chondral injury, which may affect outcome. This study was therefore conducted to prospectively assess the clinical, functional, and stability outcomes of combined ACLR and LET specifically in patients with a large (grade II or III) preoperative pivot shift to determine if this combined procedure is a reliable method to restore knee function and rotatory stability in this high-risk population.

METHODS

The study was a prospective observational study carried out in the Department of Orthopedic Surgery at the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh, from July 2021 to June 2025. Patients with a unilateral primary ACL tear, with a clinically and radiologically confirmed pivot shift (grade II or III) who subsequently underwent combined arthroscopic ACL reconstruction and lateral extra-articular tenodesis were consecutively recruited, with informed consent and availability for scheduled follow-up. Patients who underwent revision ACL surgery, multifilament knee injury with concomitant repair of the posterior cruciate ligament, medial collateral ligament, or lateral collateral ligament, intra-articular fracture, prior surgery on the contralateral knee, inflammatory or degenerative joint disease, and those who were lost to follow-up prior to final assessment were excluded. Study variables included demographic factors (age, sex, BMI, residence, occupation), injury-related factors (mechanism of injury, time from injury to surgery, presence of a pivot-shift and Lachman grade, giving-way episodes, return to pre-injury activity level, and postoperative complications, including knee stiffness, wound infection, persistent lateral knee pain, graft failure, and reoperation). All patients received a standard arthroscopic single-bundle ACL reconstruction with a modified Lemaire-type LET performed using an iliotibial band strip and a structured rehabilitation program. Outcome variables were measured preoperatively and at final follow-up. Data were analyzed using SPSS version 26; continuous variables were presented as mean ± SD and compared by paired t-test, and categorical variables were presented as frequency and percentage and compared by chi-square or McNemar test as appropriate; $p<0.05$ was considered statistically significant.

RESULTS

Demographic and baseline characteristics of the 45 study participants are shown in Table 1. The mean age was 27.8±6.4 years, with more than half (55.6%) aged 21–30 years. Males comprised 66.7% of patients. Mean BMI was 24.6±2.8 kg/m², with 57.8% having a normal BMI. In 57.8% of cases, the right knee was involved. The majority of patients lived in urban areas (60.0%), and the most common occupational groups were service workers (28.9%) and students (26.7%).

The clinical and injury profile of the participants is described in Table 2. The most frequent mechanisms of injury were sports-related injury (42.2%), road traffic accidents (28.9%), and falls (20.0%). The majority of patients (42.2%) were seen over six months after injury. The distribution of the pivot-shift grade was similar, with 62.2% being grade II and 37.8% being grade III, and the same distribution was seen with the Lachman test. Sixty percent of patients had an associated meniscal injury, and 22.2% had a chondral lesion. 88.9% of patients reported giving-way episodes preoperatively.

Table 3 shows preoperative and postoperative functional outcomes. The mean IKDC subjective score improved from 51.8±8.7 to 87.6±7.2, and the mean Lysholm score improved from 55.4±9.5 to 91.2±6.8 ($p<0.001$ for both). Preoperatively, 82.2% and 80.0% of patients had poor IKDC and Lysholm categories, respectively, while at final follow-up 86.7% and 88.9% had excellent or good IKDC and Lysholm categories, respectively.

Table 1: Demographic and baseline characteristics of the study participants (n=45).

Variables	Category	N (%)
Age (years)	Mean ± SD	27.8 ± 6.4
	≤20	6 (13.3)
	21-30	25 (55.6)
	31-40	11 (24.4)
	>40	3 (6.7)
Sex	Male	30 (66.7)
	Female	15 (33.3)
BMI, kg/m²	Mean ± SD	24.6 ± 2.8
	Normal, 18.5-24.9	26 (57.8)
	Overweight, 25.0-29.9	17 (37.8)
	Obese, ≥30.0	2 (4.4)
Affected knee	Right	26 (57.8)
	Left	19 (42.2)
Residence	Urban	27 (60.0)
	Rural	18 (40.0)
Occupation/activity	Student	12 (26.7)
	Service holder	13 (28.9)
	Manual worker	10 (22.2)
	Athlete/sports-related	6 (13.3)
	Others	4 (8.9)

Table 2: Clinical and injury profile of the study participants (n=45).

Variables	Category	N (%)
Mechanism of injury	Sports-related injury	19 (42.2)
	Road traffic accident	13 (28.9)
	Fall	9 (20.0)
	Others	4 (8.9)
Duration from injury to surgery	<3 months	9 (20.0)
	3-6 months	17 (37.8)
	>6 months	19 (42.2)
Preoperative pivot-shift grade	Grade II	28 (62.2)
	Grade III	17 (37.8)
Preoperative Lachman test	Grade II	27 (60.0)
	Grade III	18 (40.0)
Associated meniscal injury	None	18 (40.0)
	Medial meniscus	15 (33.3)
	Lateral meniscus	8 (17.8)
	Both menisci	4 (8.9)
Chondral lesion	Present	10 (22.2)
	Absent	35 (77.8)
Preoperative giving-way episodes	Present	40 (88.9)
	Absent	5 (11.1)

Table 3: Preoperative and postoperative patient-reported functional outcomes (n=45).

Variables	Category	Preoperative	Final follow-up	P value
IKDC subjective score	Mean±SD	51.8±8.7	87.6±7.2	<0.001
IKDC category	Excellent, ≥90	0 (0.0)	21 (46.7)	<0.001
	Good, 80-89	1 (2.2)	18 (40.0)	
	Fair, 70-79	7 (15.6)	5 (11.1)	
	Poor, <70	37 (82.2)	1 (2.2)	
Lysholm score	Mean±SD	55.4±9.5	91.2±6.8	<0.001

Continued.

Variables	Category	Preoperative	Final follow-up	P value
Lysholm category	Excellent, 95-100	0 (0.0)	18 (40.0)	<0.001
	Good, 84-94	1 (2.2)	22 (48.9)	
	Fair, 65-83	8 (17.8)	4 (8.9)	
	Poor, <65	36 (80.0)	1 (2.2)	

Table 4: Changes in objective knee stability following combined ACLR and LET (n=45).

Variables	Category	Preoperative N (%)	Final follow-up N (%)
Pivot-shift test	Negative	0 (0.0)	40 (88.9)
	Grade I	0 (0.0)	4 (8.9)
	Grade II	28 (62.2)	1 (2.2)
	Grade III	17 (37.8)	0 (0.0)
Lachman test	Negative	0 (0.0)	39 (86.7)
	Grade I	0 (0.0)	5 (11.1)
	Grade II	27 (60.0)	1 (2.2)
	Grade III	18 (40.0)	0 (0.0)
Giving-way episodes	Present	40 (88.9)	3 (6.7)
	Absent	5 (11.1)	42 (93.3)

Table 5: Overall clinical outcomes and postoperative complications at final follow-up (n=45).

Variables	Category	N (%)
Overall functional outcome based on Lysholm score	Excellent	18 (40.0)
	Good	22 (48.9)
	Fair	4 (8.9)
	Poor	1 (2.2)
Residual pivot-shift instability	Absent	40 (88.9)
	Grade I	4 (8.9)
	Grade II	1 (2.2)
Return to pre-injury activity level	Yes	36 (80.0)
	No	9 (20.0)
Knee stiffness	Present	3 (6.7)
	Absent	42 (93.3)
Superficial wound infection	Present	1 (2.2)
	Absent	44 (97.8)
Persistent lateral knee pain/discomfort	Present	3 (6.7)
	Absent	42 (93.3)
Graft failure/recurrent ACL rupture	Present	1 (2.2)
	Absent	44 (97.8)
Reoperation	Required	1 (2.2)
	Not required	44 (97.8)

The changes in objective knee stability are shown in Table 4. All patients preoperatively had a grade II or III pivot-shift and Lachman test. The pivot-shift test was negative in 88.9% of patients at final follow-up, and the Lachman test was negative in 86.7% of patients, with none having a grade III result on either test. The proportion of giving-way episodes fell from 88.9% preoperatively to 6.7% at the final follow-up.

The overall clinical results and complications at final follow-up are summarized in Table 5. The overall functional outcome by Lysholm category was excellent or good in 88.9% of patients, and 80.0% returned to their pre-injury activity level. 88.9% of patients had no residual pivot-shift instability. Complications were rare: knee stiffness (6.7%), superficial wound infection (2.2%), persistent lateral knee pain (6.7%), graft failure (2.2%), and reoperation was necessary in one patient (2.2%)

DISCUSSION

Combined ACLR and LET resulted in improvements in both subjective and objective outcomes, with the IKDC and Lysholm scores improving from a “poor” range preoperatively to a “good-to-excellent” range at final

follow-up in this prospective study of 45 patients with significant pivot shift. Both scores showed gains that were well above the previously reported minimal clinically important difference, which suggests that the gains were clinically meaningful, rather than just statistically significant.[11] The results are in line with Muller et al, who showed that patients undergoing ACLR with an anterolateral procedure reliably achieve patient-acceptable symptom-state thresholds on the IKDC form.[12] The restoration of rotatory stability seen in this study (88.9% negative pivot shift and 86.7% negative Lachman test at final follow-up) is similar to that reported by Kunze et al, who have consistently shown that LET combined with ACLR results in better control of anterolateral rotatory laxity and a significantly higher rate of negative or grade I pivot shift compared to ACLR alone.[13] The high percentage of knees with high-grade preoperative laxity that were completely resolved in the present series (88.9% preoperatively to 6.7% postoperatively) further supports the functional benefit of restoring anterolateral control in knees with high-grade preoperative laxity. The rate of associated meniscal injury (60%) in this study is consistent with Venkataraman et al., who reported that meniscal injury is common with ACL injury and may impact postoperative outcomes if not treated appropriately.[14] In addition, generalized joint hyperlaxity and increased risk of graft failure after ACL reconstruction have been linked to concomitant meniscal injury, further supporting the indication for anterolateral augmentation in patients with meniscal compromise.[15] In this study, however, only one patient failed the graft (2.2%), which is favorable when compared with revision rates among high-risk athletic populations undergoing combined ACLR and LET.[16] The complication rates in this study were low and similar to those found in the larger LET literature. The most common adverse events reported were knee stiffness (6.7%), persistent lateral-sided knee pain (6.7%), and superficial wound infection (2.2%). Systematic reviews that have specifically addressed LET-related complications have also shown that the complications associated with the procedure are generally mild, self-limiting, and mostly related to hardware irritation or lateral-sided discomfort, and not major structural complications.[17] There is no evidence to support concerns about lateral compartment over constraint or accelerated degenerative change after LET from modern imaging-based reviews, which report that clinically significant over constraint is rare when the tenodesis is properly tensioned.[18] In our results, 80% of patients returned to pre-injury activity level, which is comparable to pooled return-to-sport rates reported in recent systematic reviews and meta-analyses of combined ACLR and LET, which showed no meaningful difference in return-to-sport rates with the addition of LET to ACLR.[19,20] The overall results indicate that combined ACLR and LET is an effective technique for restoring function and rotatory stability in patients with a large pivot shift preoperatively.

Limitations

The study was limited by the lack of a comparison group of patients undergoing isolated ACL reconstruction, and the relatively small sample size in a single center, which may affect the generalizability of the results.

CONCLUSION

Patients with significant pivot shift had significant improvement in IKDC and Lysholm functional scores with combined ACL reconstruction and lateral extra-articular tenodesis. In most patients, objective knee stability was restored, and negative pivot-shift and Lachman tests were obtained at final follow-up. There was a reduction in giving-way episodes, and the majority of patients returned to their pre-injury activity level. Complications were rare and usually mild. The results of this study suggest that combined ACLR and LET is an effective surgical strategy for patients with high-grade preoperative rotatory instability, and larger comparative studies are warranted to further validate these results.

Recommendations

Further multicenter randomized controlled trials with long-term follow-up comparing combined ACLR and LET with isolated ACLR are recommended to provide definitive treatment guidelines for patients with large pivot shift preoperatively.

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REFERENCES

1. Bram JT, Magee LC, Mehta NN, Patel NM, Ganley TJ. Anterior cruciate ligament injury incidence in adolescent athletes: a systematic review and meta-analysis. Am J Sports Med. 2021;49(7):1962-72.
2. Musahl V, Getgood A, Neyret P, Claes S, Burnham JM, Batailler C, et al. Contributions of the anterolateral complex and the anterolateral ligament to rotatory knee stability in the setting of ACL injury: a roundtable discussion. Knee Surg Sports Traumatol Arthrosc. 2017;25(4):997-1008.
3. Lucidi GA, Hughes JD, Herbst E, Burnham JM, Musahl V. Role of the anterolateral complex in rotatory instability of the anterior cruciate ligament deficient knee. Ann Joint. 2017;2(6).
4. Getgood A, Bryant D, Firth A. The STABILITY study: a protocol for a multicenter randomized clinical trial comparing anterior cruciate ligament reconstruction with and without lateral extra-articular tenodesis in individuals who are at high risk of graft failure. BMC Musculoskelet Disord. 2019;20(1):216.
5. Getgood AM, Bryant DM, Litchfield R, Heard M, McCormack RG, Rezansoff A, et al. Lateral extra-

articular tenodesis reduces failure of hamstring tendon autograft anterior cruciate ligament reconstruction: 2-year outcomes from the STABILITY study randomized clinical trial. Am J Sports Med. 2020;48(2):285-97.
6. Mao Y, Zhang K, Li J, Fu W. Supplementary lateral extra-articular tenodesis for residual anterolateral rotatory instability in patients undergoing single-bundle anterior cruciate ligament reconstruction: a meta-analysis of randomized controlled trials. Orthop J Sports Med. 2021;9(5):23259671211002282.
7. Park YB, Lee HJ, Cho HC, Pujol N, Kim SH. Combined lateral extra-articular tenodesis or combined anterolateral ligament reconstruction and anterior cruciate ligament reconstruction improves outcomes compared to isolated reconstruction for anterior cruciate ligament tear: a network meta-analysis of randomized controlled trials. Arthroscopy. 2023;39(3):758-76.
8. Feng J, Cao Y, Tan L, Liang J, He C, He J, et al. Anterior cruciate ligament reconstruction with lateral extra-articular tenodesis reduces knee rotation laxity and graft failure rate: a systematic review and meta-analysis. J Orthop Surg (Hong Kong). 2022;30(1):10225536221095969.
9. Damayanthi ED, Kholinne E, Singjie LC, Sakti M, Anesstesia IJ. Combined anterior cruciate ligament reconstruction (ACLR) and lateral extra-articular tenodesis through the modified Lemaire technique versus isolated ACLR: a meta-analysis of clinical outcomes. Rev Bras Ortop. 2024;59(2):180-8.
10. Bosco F, Giustra F, Masoni V, Capella M, Sciannameo V, Camarda L, et al. Combining an anterolateral complex procedure with anterior cruciate ligament reconstruction reduces the graft reinjury rate and improves clinical outcomes: a systematic review and meta-analysis of randomized controlled trials. Am J Sports Med. 2024;52(8):2129-47.
11. Nascimento BF, Lima MB, Dias JM, Antunes Filho J, Campos TV, Mendes AF. Calculation of the minimal important clinical difference of the Lysholm and IKDC scores after anterior cruciate ligament reconstruction. Rev Bras Ortop. 2023;58(1):79-84.
12. Muller B, Yabroudi MA, Lynch A, Lai CL, Van Dijk CN, Fu FH, et al. Defining thresholds for the patient acceptable symptom state for the IKDC subjective knee form and KOOS for patients who underwent ACL reconstruction. Am J Sports Med. 2016;44(11):2820-6.
13. Kunze KN, Manzi J, Richardson M, White AE, Coladonato C, DePhillipo NN, et al. Combined anterolateral and anterior cruciate ligament reconstruction improves pivot shift compared with isolated anterior cruciate ligament reconstruction: a systematic review and meta-analysis of randomized controlled trials. Arthroscopy. 2021;37(8):2677-703.
14. Venkataraman S, Ethiraj P, Shanthappa AH, Vellingiri K. Association of meniscus injuries in patients with anterior cruciate ligament injuries. Cureus. 2022;14(6).
15. Krebs NM, Barber-Westin S, Noyes FR. Generalized joint laxity is associated with increased failure rates of primary anterior cruciate ligament reconstructions: a systematic review. Arthroscopy. 2021;37(7):2337-47.
16. Borque KA, Jones M, Laughlin MS, Balendra G, Willinger L, Pinheiro VH, et al. Effect of lateral extra-articular tenodesis on the rate of revision anterior cruciate ligament reconstruction in elite athletes. Am J Sports Med. 2022;50(13):3487-92.
17. Zabrzyński J, Erdmann J, Zabrzyńska M, Łapaj Ł, Malik SS, Kwapisz A. Are there any complications after lateral extra-articular tenodesis in anterior cruciate ligament reconstruction? A systematic review. J Orthop Surg Res. 2025;20(1):451.
18. Marshall DC, Silva FD, Goldenberg BT, Quintero D, Baraga MG, Jose J. Imaging findings of complications after lateral extra-articular tenodesis of the knee: a current concepts review. Orthop J Sports Med. 2022;10(8):23259671221114820.
19. Deshpande VA, Mathur A, Barnett I, Frausto J, Saunders P, Gazzaniga DS, et al. No significant difference in return-to-sport rates between anterior cruciate ligament reconstruction with lateral extra-articular tenodesis and isolated anterior cruciate ligament reconstruction: a systematic review and meta-analysis. Am J Sports Med. 2026;54(5):1215-25.
20. Nukuto K, Konstantinou E, Wackerle AM, Lagreca JC, Grandberg C, Park YL, et al. Meniscus tears in the setting of anterior cruciate ligament injury. Jt Surg Res. 2024;2(4):180-8.

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