A Prospective Study of a Functional Outcome of Single Stage Revision Anterior Cruciate Ligament Reconstruction with Lateral Extra Articular Tenodesis in a Tertiary Care Centre in Chengalpattu District

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ABSTRACT

Introduction: Anterior cruciate ligament (ACL) graft failure remains a challenging problem, particularly in young active individuals with persistent rotational instability. Isolated revision ACL reconstruction may not adequately restore anterolateral rotatory control, predisposing to graft overload and re-failure. Lateral extra-articular tenodesis (LET) has gained renewed interest as an adjunct procedure to improve rotational stability in revision settings.

Aims and Objectives: To evaluate the functional and clinical outcomes of single-stage revision ACL reconstruction combined with lateral extra-articular tenodesis, with emphasis on knee stability, rotational control, functional recovery, and complication profile.

Materials and Methods: This prospective observational study was conducted in the Department of Orthopaedics at Shri Sathya Sai Medical College Hospital and Research Centre, Chengalpattu district, Tamil Nadu, from June 2024 to November 2025. Twenty-eight adult patients with Grade II or III ACL graft failure following primary reconstruction were included using consecutive sampling. Ethical approval was obtained from the Institutional Human Ethics Committee (IEC No: 1010/24). All patients underwent single-stage revision ACL reconstruction with autologous hamstring graft combined with modified Lemaire LET. Functional outcomes were assessed using the Lysholm score, Modified Cincinnati Score, and AOFAS score at baseline and during follow-up. Clinical stability was evaluated using Lachman and pivot shift tests. Data were analysed using SPSS version 29, with $p < 0.05$ considered statistically significant.

Results: The majority of patients were aged 20–40 years (67.9%) and predominantly male (64.3%). Right-sided involvement was seen in 57.1% of cases. Road traffic accidents were the leading cause of injury (42.9%). Most patients presented within 1–3 years following primary ACL reconstruction, and Grade III graft tears were observed in 53.6% of cases. Significant functional improvement was noted at all follow-up intervals ($p < 0.001$). The mean Lysholm score improved from 52.6 ± 8.1 preoperatively to 94.5 ± 3.6 at 6 months. AOFAS score increased from 61.5 ± 7.9 to 96.9 ± 3.1, and Cincinnati score improved from 53.9 ± 7.1 to 95.3 ± 3.3. Mean knee range of motion improved from 78.3° ± 5.9° to 129.4° ± 6.6°. By 6 months, all patients achieved Grade 0 Lachman and pivot shift tests. Complications were minimal.

Conclusion: Single-stage revision ACL reconstruction augmented with lateral extra-articular tenodesis provides significant functional improvement, effective rotational stability, and acceptable complication rates, making it a reliable option for managing failed primary ACL reconstruction.

Keywords: Anterior cruciate ligament reconstruction; Revision ACL; Lateral extra-articular tenodesis; Rotational instability; Functional outcome.

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INTRODUCTION

Anterior cruciate ligament (ACL) injuries are among the most common and clinically significant knee injuries, particularly in adolescents and young adults involved in pivoting and high-demand sports [1]. The incidence has risen in recent years due to increased sports participation, improved diagnostic awareness, and early return to activity [2]. The ACL plays a crucial role in maintaining knee stability by restraining anterior tibial translation and controlling rotational movements; its deficiency leads to instability, recurrent giving-way episodes, and progressive meniscal and chondral damage [3].Arthroscopic ACL reconstruction (ACLR) is the gold-standard treatment, with advances in surgical techniques and rehabilitation yielding favorable outcomes. However, a subset of patients continues to experience residual instability, especially rotational instability, which increases the risk of graft failure, particularly in young active individuals [4]. Failure rates range from 3% to 20% and are higher in high-risk populations [5-7]. Contributing factors include technical errors, biological issues, reinjury, and unaddressed associated injuries, with persistent rotational instability being a major cause [8,9].Isolated ACLR restores anterior stability but may not adequately correct rotational laxity, with 25–30% of patients demonstrating a positive pivot shift [9,10]. Injury to the anterolateral complex significantly contributes to this instability [11,12].

Lateral extra-articular tenodesis (LET) has regained importance due to improved biomechanical understanding [13,14]. It reduces rotational laxity, decreases graft strain, and lowers failure rates, especially in high-risk and revision cases [15-17].

Revision ACL reconstruction is technically demanding due to altered anatomy and associated injuries [18]. Combining ACLR with LET improves rotational control and outcomes, while single-stage revision reduces morbidity [19,20]. Despite growing evidence, prospective data from India remain limited [21,22], highlighting the need for further research.

AIM AND OBJECTIVES

AIM

This study evaluates the effectiveness of single-stage revision anterior cruciate ligament (ACL) reconstruction combined with lateral extra-articular tenodesis (LET) in enhancing knee stability, reducing graft re-rupture risk, and improving functional outcomes in patients with failed or unstable primary ACL reconstruction.

OBJECTIVES

1. To assess the functional outcomes of patients undergoing single-stage revision ACL reconstruction with lateral extra-articular tenodesis using validated clinical scoring systems.
2. To evaluate postoperative knee stability, particularly rotational stability, following the combined ACLR and LET procedure.
3. To determine the improvement in patient-reported outcomes and functional performance over the follow-up period after surgery.
4. To analyse the incidence of complications and graft failure following single-stage revision ACL reconstruction augmented with LET.

MATERIALS AND METHODS

Study Design

This prospective observational study evaluates functional outcomes of single-stage revision anterior cruciate ligament reconstruction (ACLR) combined with lateral extra-articular tenodesis (LET) in patients with failed primary ACL reconstruction

Study Area

The study was conducted in the Department of Orthopaedics at Shri Sathya Sai Medical College Hospital and Research Centre, serving predominantly rural patients from Chengalpattu district, Tamil Nadu.

Study Period

The study duration was 18 months, from June 2024 to November 2025.

Study Population

Adult patients presenting with clinical and radiological evidence of Grade II or III ACL graft failure following prior reconstruction were included.

Subject Selection & Ethical Considerations

Approval was obtained from the Institutional Human Ethics Committee (IEC No: 1010/24, dated 23 April 2024). Eligible patients were enrolled after informed written consent. The study posed no additional risk beyond standard care, and patient confidentiality was strictly maintained.

Sample Size Calculation

Sample size was calculated based on previous published studies by Mishra AK et al(2018) [92]. The expected proportions of negative pivot shift as 0.933 with the relative precision of 10%. The 5% level of significance was considered; the calculated sample size was 28 patients.

$$n \geq \frac{Z_{1-\frac{\alpha}{2}}^{2} p(1-p)}{(dp)^2}$$

Where p is the expected proportion or prevalence of event of interest for the study

d is the relative precision

$Z_{1-\frac{\alpha}{2}}$ is normal deviate at a level of significance

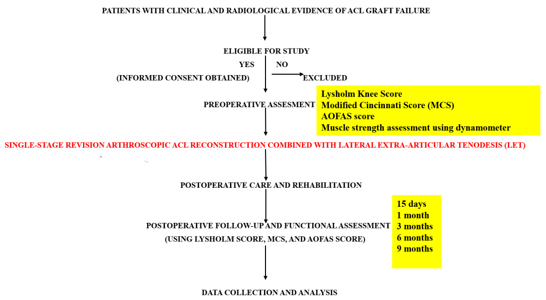
$$n \geq \frac{(1.96)^2\, 0.933(1-0.933)}{(0.10 * 0.933)^2}$$

$$n \geq 28$$

Sampling Methodology

A non-probability consecutive sampling technique was employed, wherein all eligible patients meeting inclusion criteria during the study period were enrolled until the required sample size was achieved.

StudyProcedure



Preoperative Assessment

All patients underwent a standardized preoperative evaluation, which included:

- Detailed clinical history (mechanism of injury, duration since primary surgery, instability symptoms)
- Clinical examination of the knee including:
  - Anterior drawer test
  - Lachman test
  - Pivot shift test
- Radiological evaluation with MRI to confirm graft failure
- Baseline functional assessment using:
  - Lysholm Knee Scoring Scale [93]
  - Modified Cincinnati Score (MCS)[94]
  - AOFAS score[95]
- Measurement of muscle strength:
  - Knee flexion and extension
  - Ankle plantar flexion and eversionusing a hand-held dynamometer

SURGICAL PROCEDURE

Single-Stage Revision Arthroscopic Anterior Cruciate Ligament Reconstruction (ACLR) with Lateral Extra-Articular Tenodesis (LET)
using either:

1. Peroneus Longus Tendon Autograft, or
2. Hamstring Tendon Autograft

1. Patient Positioning and Preparation

The patient was positioned supine on the operating table with a lateral thigh post and foot support to facilitate knee stabilization and traction during the procedure. Either spinal anesthesia or general anesthesia was administered according to the anesthetic plan. The operative limb was scrubbed and draped in a sterile manner following standard aseptic precautions.

Graft Harvesting

2. Peroneus Longus Tendon Autograft Harvest

A 2–3 cm longitudinal incision was made over the posterolateral aspect of the distal leg, approximately 2 cm proximal to the lateral malleolus.The peroneus longus tendon was identified posterior to the peroneus brevis tendon and carefully isolated while protecting the superficial peroneal nerve.

The tendon was transected distally and gently dissected proximally using a tendon stripper to obtain adequate graft length, usually measuring approximately 24–26 cm.

The harvested tendon was cleared of surrounding soft tissue and muscle fibers. Both ends of the graft were whipstitched using non-absorbable sutures. The graft length and diameter were measured to facilitate appropriate tunnel preparation.

3. Hamstring Tendon Autograft Harvest

A 3–4 cm oblique incision was made over the pes anserinus region, approximately 3–4 cm distal and medial to the tibial tuberosity.The semitendinosus tendon was identified and isolated, and the gracilis tendon was harvested when required. After releasing fascial adhesions, the tendons were transected distally and harvested proximally using a tendon stripper.The harvested tendons were cleared of muscle tissue and folded to create a triple or quadruple graft depending on the required graft diameter and length. Both ends were whipstitched with non-absorbable sutures, and the graft was sized accordingly.

Arthroscopic Procedure

4. Arthroscopy and Portal Placement

Diagnostic arthroscopy was performed via standard anteromedial (AM) and anterolateral (AL) portals. The AM portal was placed ~1 cm medial to the patellar tendon near the tibial plateau to enable perpendicular femoral tunnel drilling, with position confirmed using a spinal needle and adjusted (enlarged/accessory portal) as needed. Concomitant intra-articular pathologies were treated. The ACL stump was debrided to expose femoral and tibial footprints, and notchplasty was performed in chronic cases using a shaver or burr to improve visualization and prevent graft impingement.

Tunnel Preparation

5. Tibial Tunnel Preparation

A 55° ACL tibial guide was introduced through the anteromedial portal, with the tip positioned ~7 mm anterior to the PCL, posterior to the anterior horn of the lateral meniscus, and at the lateral wall of the medial tibial spine. The tibial tunnel (8–10 mm) was sized according to the graft. A guide pin was inserted from a point midway between the tibial tubercle and the posteromedial tibial border, followed by cannulated reaming to the required depth.

6. Femoral Tunnel Preparation

The femoral notch was prepared and the bifurcate ridge identified. Femoral tunnels were created at the anatomic insertion sites of the AM and AL bundles. With the knee in hyperflexion, the femoral tunnel was drilled via the anteromedial portal using a Beath pin, followed by a 4.5 mm drill through the cortex, maintaining an exit point 6–7 mm anterior to the posterior cortex. The tunnel was reamed to the graft diameter (7.5–8.5 mm) to a depth of 10–20 mm, avoiding breach of the posterior and lateral co

Drilling Technique

With the knee in hyperflexion, a Beath pin was advanced through the lateral femoral cortex, ensuring an appropriate exit point and repositioning if excessively posterior. Cannulated reamers were then passed over the guide pin to create the femoral tunnel, with adjustments made in cases of limited visualization or tight portals. The tunnel was typically drilled 1 mm smaller than the intended graft diameter, followed by gradual enlargement using dilators in 0.5 mm increments as needed. Debris was cleared using a shaver.

Graft Passage and Fixation

7. Passage and Fixation of the Graft

A No. 2 Ethibond suture loop was passed through the tibial tunnel into the joint and retrieved via the femoral tunnel. The graft was attached and shuttled sequentially through the tibial tunnel, across the joint, and into the femoral tunnel. Femoral fixation was achieved using an Endo button deployed over the lateral femoral cortex. The graft was cycled to eliminate slack and ensure proper tension. Tibial fixation was then performed with a bio- or titanium interference screw at approximately 30° knee flexion under posterior drawer force.

Lateral Extra-Articular Tenodesis (Modified Lemaire Technique)

Following intra-articular revision ACL reconstruction, lateral extra-articular tenodesis was performed to address residual anterolateral rotational instability. An 8–10 cm × 1 cm strip of iliotibial band was harvested, preserving its distal attachment at Gerdy's tubercle. The graft was passed deep to the LCL and fixed proximally at the lateral femoral condyle near the lateral epicondyle using a suture anchor or interference screw, with the knee at 30° flexion and neutral tibial rotation to prevent over-constraint.

Closure and Postoperative Care

A final arthroscopic assessment confirmed appropriate graft position and tension. Portals and incisions were closed in layers, followed by application of a sterile compression dressing and knee immobilizer. All procedures were performed by the same team of experienced surgeons using standardized arthroscopic techniques to ensure uniformity.

Figure 4: POD-2 dressing- lateral incision (LET incision)

Figure 5: POD-2 dressing - tibial/anterior incision (ACLR incision)

ACL Rehabilitation Protocol:

Stage I: 0 to 2 weeks

- Patella mobilization
- Motion control brace 0 to 90 degrees
- Quadriceps sets/straight leg raising in all planes (emphasize SLR without extension lag)
- Prone/standing hamstring curls
- Passive extension (emphasize full extension)
- Prone hangs
- Pillow under the heel
- Passive, active, and active-assisted ROM knee flexion
- Wall slide
- Sitting slide
- Partial weight-bearing 50 to 75% with crutches or weight-bearing to tolerance without crutches if the motion control brace is locked in full extension
- Sleep in the brace locked in full extension

Goals:

- Full knee extension
- 90-degree knee flexion
- Good quadriceps strength
- Emphasize normal gait

Stage II: 2 to 4 weeks

- Motion control brace – full range of motion
- Progress ROM to 120 degrees by the fourth week
- Progress SLR and prone/standing hamstring curls with weights
- Full weight-bearing with crutches and discontinue crutches when ambulating without a limp
- Wall sits at 45-degree angle with tibia vertical, progress time

Knee extension 90 to 60 degrees with manual resistance by therapist

Goals:

Range of motion 0 to 120 degrees

Full weight-bearing with crutches and no limp

Stage II: 4 to 10 weeks

Progress to full ROM by 6 weeks

Begin lunges

Continue strengthening of lower extremity muscle groups, especially through the full range of hamstring/quadriceps

Stage II: 2 to 4 weeks

Motion control brace – full range of motion

Progress ROM to 120 degrees by the fourth week

Stage II: 4 to 10 weeks

- Progress SLR and prone/standing hamstring curls with weights
- Full weight-bearing with crutches and discontinue crutches when ambulating without a limp
- Wall sits at a 45-degree angle with tibia vertical, progress time
- Knee extension 90 to 60 degrees with manual resistance by therapist

Goals:

- Range of motion – 0 to 120 degrees
- Full weight-bearing with crutches and no limp
- Progress to full ROM by 6 weeks
- Begin lunges
- Continue strengthening of lower extremity muscle groups, especially through the full range of hamstring/quadriceps

Stage III: 12 to 16 weeks

- Continue flexibility exercises
- Quadriceps strength progression
- Sports-specific cardiovascular fitness

Stage IV: 16 to 18 weeks

- Begin plyometric program with shuttle, mini trampoline if quadriceps strength 65%, no effusion, full range of motion, stable knee
- Begin jogging program if quadriceps strength 65%

Stage V: 5 to 6 months

- Sports-specific drills
- Agility training

Stage VI: 6 months

Return to sport if:

- Knee Range of Motion >130 degrees
- Hamstring strength >90%
- Quadriceps strength >85%
- Sports-specific agility training completed

Follow-Up and Outcome Assessment

Patients were followed up postoperatively at **15 days, 1 month, 3 months, 6 months, and 9 months**. At each visit, clinical examination for knee stability and functional outcome assessment using Lysholm score, Modified Cincinnati Score, and AOFAS score were performed.postoperatively.

Functional outcomes were assessed using:

- Lysholm Knee Score [93]
- Modified Cincinnati Score [94]
- AOFAS score [95]

Clinical stability was evaluated using standard physical examination tests during follow-up visits.

ANALYSIS AND RESULTS

Table 1: Age distribution of study participants

Age	Frequency	Percent
18-20	3	10.7
20-40	19	67.9
40-49	6	21.4
Total	28	100.0

The majority of participants were in the 20–40 years age group (67.9%, n=19), followed by 40–49 years (21.4%, n=6). The least represented group was 18–20 years (10.7%, n=3).

Figure 1: Age distribution of study participants

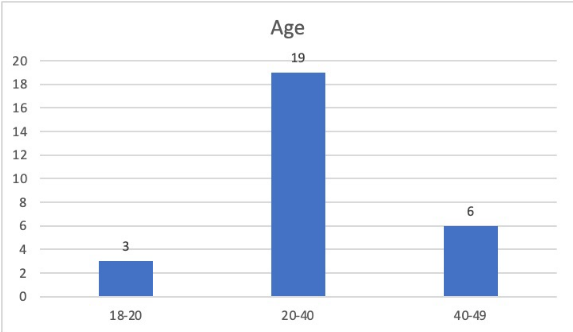


Table 2: Gender distribution of study participants

Sex	Frequency	Percent
Female	10	35.7
Male	18	64.3
Total	28	100.0

Male participants predominated, comprising 64.3% (n=18), while females accounted for 35.7% (n=10).

Table 3: Distribution of study participants based on side of injury

Side	Frequency	Percent
Left	12	42.9
Right	16	57.1
Total	28	100.0

Right-sided injuries were more common (57.1%, n=16) compared to left-sided injuries (42.9%, n=12).

Table 4: Distribution of study participants based on mode of injury

Mode of injury	Frequency	Percent
Fall	6	21.4
Sports	4	14.3
RTA	12	42.9
Other	6	21.4
Total	28	100.0

Road traffic accidents (RTA) were the most common cause (42.9%, n=12). Falls and other causes each accounted for 21.4% (n=6 each), while sports-related injuries were least common (14.3%, n=4).

Figure 4: Distribution of study participants based on mode of injury

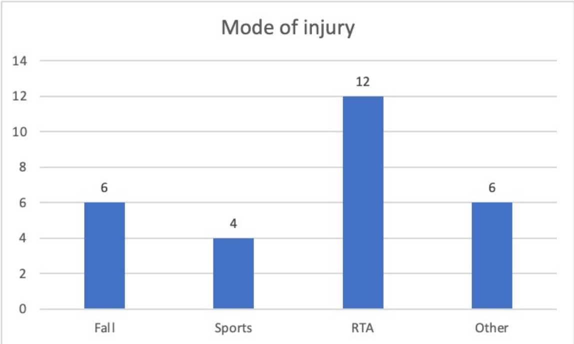


Table 5: Distribution of study participants based of duration of ACLR

Time since ACLR	Frequency	Percent
<1 year	8	28.6
1–3 years	12	42.9
>3 years	8	28.6
Total	28	100.0

Table 5 shows the distribution of study participants based on the duration since ACL reconstruction (ACLR). The majority of participants had undergone ACLR 1–3 years prior, comprising 12 individuals (42.9%). Participants with a duration of less than 1 year and more than 3 years each accounted for 8 individuals (28.6% each).

Table 6: Distribution of study participants according to previous graft

Previous graft	**Frequency**	**Percent**
BPTB	9	32.1
QT	6	21.4
Hamstring	13	46.4
Total	28	100.0

Table 6 shows the distribution of study participants according to the type of previous graft used for ACL reconstruction. The most commonly used graft was the hamstring graft, accounting for 13 participants (46.4%), followed by bone–patellar tendon–bone (BPTB) graft in 9 participants (32.1%). Quadriceps tendon (QT) graft was used in 6 participants (21.4%).

Figure 6: Distribution of study participants according to previous graft

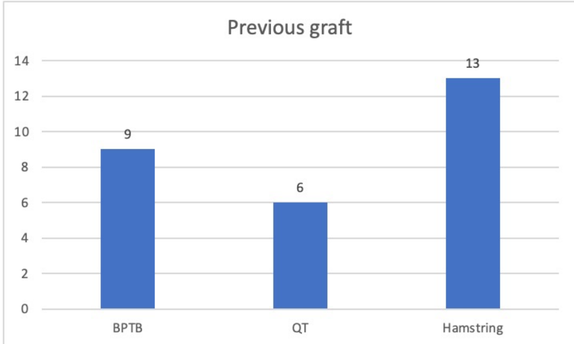


Table 7: Distribution of study participants according to MRI tear grade

MRI Tear Grade	**Frequency**	**Percent**
Grade II	13	46.4
Grade III	15	53.6
Total	28	100.0

Table 7 shows the distribution of study participants according to MRI tear grade. The majority of participants had Grade III tears, comprising 15 individuals (53.6%), while 13 participants (46.4%) had Grade II tears.

Table 8: Comparison of Lysholm score at different follow-up

Lysholm	Mean	Std. Deviation	P value
Pre-op	52.6	8.1	
Week 3	72.9	4.6	<0.001*
Week 6	84.6	3.2	<0.001*
Month 3	90.0	3.2	<0.001*
Month 6	94.5	3.6	<0.001*

Table 8 shows the comparison of mean Lysholm scores at different follow-up periods. The mean pre-operative Lysholm score was 52.6 ± 8.1, which progressively improved to 72.9 ± 4.6 at week 3, 84.6 ± 3.2 at week 6, 90.0 ± 3.2 at month 3, and 94.5 ± 3.6 at month 6. The improvement in scores at each follow-up interval compared to the pre-operative value was statistically highly significant ($p < 0.001$).

Figure 8: Comparison of Lysholm score at different follow-up

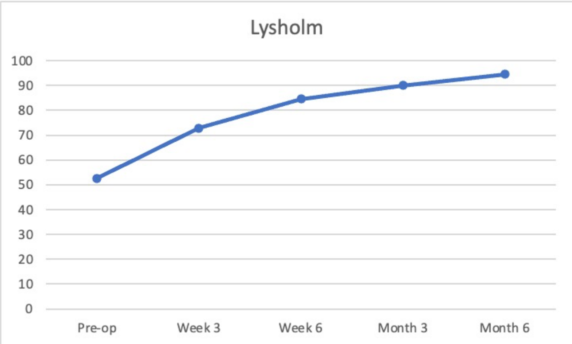


Table 9: Comparison of AOFAS score at different follow-up

AOFAS	Mean	Std. Deviation	P value
Pre-op	61.5	7.9	
Week 3	77.3	5.0	<0.001*
Week 6	86.4	2.7	<0.001*
Month 3	92.3	2.9	<0.001*
Month 6	96.9	3.1	<0.001*

Table 9 shows the comparison of mean AOFAS scores at different follow-up periods. The mean pre-operative AOFAS score was 61.5 ± 7.9, which increased to 77.3 ± 5.0 at week 3, 86.4 ± 2.7 at week 6, 92.3 ± 2.9 at month 3, and 96.9 ± 3.1 at month 6. The improvement in AOFAS scores at each follow-up interval compared to the pre-operative value was statistically highly significant ($p < 0.001$)

Table 10: Comparison of Cincinnati score at different follow-up

Cincinnati	**Mean**	**Std. Deviation**	**P value**
Pre-op	53.9	7.1	
Week 3	71.8	5.1	<0.001*
Week 6	85.5	3.6	<0.001*
Month 3	90.6	2.9	<0.001*
Month 6	95.3	3.3	<0.001*

Table 10 shows the comparison of mean Cincinnati scores at different follow-up periods. The mean pre-operative Cincinnati score was 53.9 ± 7.1, which improved to 71.8 ± 5.1 at week 3, 85.5 ± 3.6 at week 6, 90.6 ± 2.9 at month 3, and 95.3 ± 3.3 at month 6. The increase in scores at each follow-up interval compared to the pre-operative value was statistically highly significant ($p < 0.001$).

Table 11: Comparison of ROM at different follow-up

ROM	Mean	Std. Deviation	P value
Pre-op	78.3	5.9	
Week 3	91.0	6.2	<0.001*
Week 6	107.4	8.8	<0.001*
Month 3	119.9	6.2	<0.001*
Month 6	129.4	6.6	<0.001*

Table 11 shows the comparison of mean range of motion (ROM) at different follow-up periods. The mean pre-operative ROM was 78.3 ± 5.9 degrees, which increased to 91.0 ± 6.2 degrees at week 3, 107.4 ± 8.8 degrees at week 6, 119.9 ± 6.2 degrees at month 3, and 129.4 ± 6.6 degrees at month 6. The improvement in ROM at each follow-up interval compared to the pre-operative value was statistically highly significant ($p < 0.001$).

Figure 11: Comparison of ROM at different follow-up

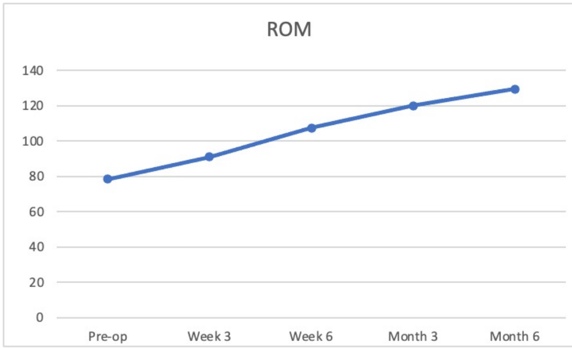


Table 12: Comparison of Lachman grade at different follow-up

Lachman		**Frequency**	**Percent**
Pre-op	Grade II	19	67.9
	Grade III	9	32.1
Week 3	Grade 0	15	53.6
	Grade I	13	46.4
Week 6	Grade 0	22	78.6
	Grade I	6	21.4
Month 3	Grade 0	24	85.7
	Grade I	4	14.3
Month 6	Grade 0	28	100.0

Table 12 shows the comparison of Lachman grade at different follow-up periods. Pre-operatively, 19 participants (67.9%) had Grade II laxity and 9 (32.1%) had Grade III laxity. At week 3, improvement was observed with 15 participants (53.6%) achieving Grade 0 and 13 (46.4%) having Grade I. By week 6, 22 participants (78.6%) were Grade 0 and 6 (21.4%) were Grade I. At month 3, 24 participants (85.7%) demonstrated Grade 0 and 4 (14.3%) remained Grade I. By month 6, all participants (100%) achieved Grade 0.

Table 13: Comparison of pivot shift grade at different follow-up

Pivot shift		Frequency	Percent
Pre-op	Grade II	19	67.9
	Grade III	9	32.1
Week 3	Grade 0	13	46.4
	Grade I	15	53.6
Week 6	Grade 0	16	57.1
	Grade I	12	42.9
Month 3	Grade 0	24	85.7
	Grade I	4	14.3
Month 6	Grade 0	28	100.0

Table 13 shows the comparison of pivot shift grade at different follow-up periods. Pre-operatively, 19 participants (67.9%) had Grade II and 9 (32.1%) had Grade III pivot shift. At week 3, improvement was observed with 13 participants (46.4%) achieving Grade 0 and 15 (53.6%) having Grade I. By week 6, 16 participants (57.1%) were Grade 0 and 12 (42.9%) were Grade I. At month 3, 24 participants (85.7%) demonstrated Grade 0 and 4 (14.3%) remained Grade I. At month 6, all participants (100%) were reported as Grade 0.

Figure 13: Comparison of pivot shift grade at different follow-up

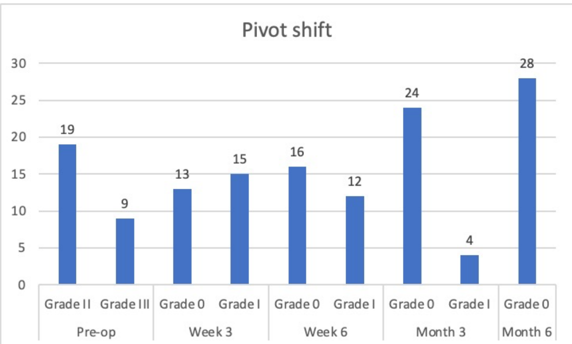


Table 14: Distribution of study participants based on complications

Complications	Frequency	Percent
Failure	4	14.3
Stiffness	4	14.3
Pain	6	21.4
Nil	14	50
Total	28	100

Table 14 shows the distribution of study participants based on post-operative complications. Half of the participants (14, 50%) reported no complications. Among those who experienced complications, pain was the most common, affecting 6 participants (21.4%), while failure and stiffness were each observed in 4 participants (14.3% each).

Figure 14: Distribution of study participants based on complication

DISCUSSION

The present study evaluates outcomes of single-stage revision ACL reconstruction with lateral extra-articular tenodesis (LET). It emphasizes the role of LET in addressing persistent rotational instability, a key factor in graft failure, aiming to improve stability, function, and complication profile.

Age and Gender distribution

Most patients were aged 20–40 years, comparable to Fritsch L et al. [22], Kulaar HS et al. [88], and Dhariwal VH et al. [96]. This reflects higher activity levels and sports participation. Male predominance is consistent with Dhariwal VH et al. [96], Shivaraj N et al. [87], and Erdmann J et al. [19], likely due to greater exposure to high-risk activities.

Characteristics of the Study Population

Right-sided predominance may relate to limb dominance. Unlike prior studies where sports injuries predominated [88,90,87,96], this study showed more road traffic injuries, possibly due to referral patterns. Early failures relate to rehabilitation and instability, while late failures reflect cumulative stress [8,9]. Hamstring graft use was common but may offer less rotational stability [7,8]. Revision graft choice varied, with BPTB used in select cases for better fixation. High-grade laxity supports LET use to reduce graft strain [15,16,98].

Functional Outcomes

Significant improvement in Lysholm scores was observed, consistent with Shivaraj N et al. [87], Kumar M et al. [90], Elango Shanthini A et al. [85], Vanage S et al. [67], and Kulaar HS et al. [88]. Erdmann J et al. [19] and Dhariwal VH et al. [96] also reported sustained improvement. Systematic review by Deshpande SS et al. [91] supports better outcomes with LET, though Fritsch L et al. [22] found no significant difference. AOFAS and Cincinnati scores also improved [85,90,91]. Range of motion improved without restriction, consistent with Shivaraj N et al. [87], Kulaar HS et al. [88], and Fritsch L et al. [22].

Rotational instability

All patients achieved Grade 0 stability by six months. Similar findings were reported by Shivaraj N et al. [87] and Erdmann J et al. [19]. Kumar et al. [88] and

Deshpande SS et al. [91] demonstrated superior rotational control with LET. Kulaar HS et al. [88], Vanage S et al. [67], and Fritsch L et al. [22] also reported improved stability. LET reduces graft stress and restores biomechanics.

Complications

Complications were minimal, mainly pain and stiffness. Graft failure rates were low and comparable to Vanage S et al. [67] and Shivaraj N et al. [87]. Other studies also reported minimal complications [85,88,96]. Deshpande SS et al. [91] found low overall complication rates. LET did not increase morbidity when performed properly.Overall, LET augmentation in revision ACL reconstruction improves stability, functional outcomes, and graft protection, supporting its use in patients with significant rotational instability.

SUMMARY AND CONCLUSION

This prospective study evaluated the functional outcomes of single-stage revision anterior cruciate ligament reconstruction (ACLR) combined with lateral extra-articular tenodesis (LET) in 28 patients.

The majority of participants were aged 20–40 years (67.9%) and were predominantly male (64.3%). Right-sided injuries were more common (57.1%). Road traffic accidents were the leading cause of injury (42.9%). Most patients had undergone primary ACL reconstruction 1–3 years prior (42.9%), with hamstring graft being the most commonly used previous graft (46.4%). MRI evaluation showed Grade III tears in 53.6% of participants.

Functional outcomes showed progressive and statistically highly significant improvement ($p < 0.001$) at all follow-up intervals:

- **Lysholm score** improved from 52.6 ± 8.1 pre-operatively to 94.5 ± 3.6 at 6 months.
- **AOFAS score** improved from 61.5 ± 7.9 to 96.9 ± 3.1 at 6 months.
- **Cincinnati score** improved from 53.9 ± 7.1 to 95.3 ± 3.3 at 6 months.
- **Range of motion (ROM)** improved from 78.3° ± 5.9° pre-operatively to 129.4° ± 6.6° at 6 months.

Knee stability showed marked improvement:

- All patients achieved Grade 0 Lachman test by 6 months.
- All patients achieved Grade 0 pivot shift by 6 months.

Regarding complications, 50% had no post-operative complications. Pain was the most common complication (21.4%), followed by stiffness (14.3%) and graft failure (14.3%).

CONCLUSION

Single-stage revision anterior cruciate ligament reconstruction combined with lateral extra-articular tenodesis is an effective surgical approach for managing failed or unstable primary ACL reconstruction. The procedure significantly improves functional outcomes, restores knee stability including rotational control, and enhances range of motion over a 6-month follow-up period.

The addition of lateral extra-articular tenodesis appears to provide excellent rotational stability, as demonstrated by complete resolution of pivot shift and Lachman laxity in all patients at final follow-up. Complication rates were acceptable and manageable.

Thus, single-stage revision ACL reconstruction augmented with LET represents a reliable and effective treatment option in a tertiary care setting

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