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Original Research Article

Comparative Study of Functional Outcome of Arthroscopic Anterior Cruciate Ligament Reconstruction with and without Lateral Extra-Articular Tenodesis (Modified Lemaire Technique)

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Abstract:

Background: Anterior Cruciate Ligament (ACL) injuries commonly result in knee instability. This study compares functional outcomes between isolated ACL Reconstruction (ACLR) and ACLR combined with Lateral Extra-articular Tenodesis (LET) using the modified Lemaire technique.

Methods: This prospective study involved 60 patients divided equally into two groups: ACLR alone and ACLR with LET. Functional outcomes were evaluated using LEFS, Tegner Lysholm, IKDC scores, and hop tests at 3, 6, 9, and 12-months follow-ups.

Results: Patients undergoing ACLR with LET showed significantly better LEFS (73.10 vs 68.57), Tegner Lysholm (92.77 vs 84.03), and IKDC (79.03 vs 72.37) scores at 12 months ($p<0.001$). Hop test scores indicated superior limb symmetry index and functional recovery in the ACLR with LET group.

Conclusion: ACLR combined with LET significantly improves knee stability, functional recovery, and patient satisfaction compared to isolated ACLR. Augmentation with LET is recommended for younger patients involved in pivoting sports, although further long-term studies are needed.

Keywords: ACL Reconstruction, Lateral Extra-articular Tenodesis, Knee Stability, Functional Outcomes

Introduction

Anterior cruciate ligament (ACL) injuries are among the most prevalent ligamentous injuries of the knee. Anterior cruciate ligament reconstruction (ACLR) aims to restore knee biomechanics, providing stability and preventing further joint

damage [1]. Despite advancements in ACLR techniques, persistent instability, particularly rotational laxity, remains a significant challenge in clinical outcomes, affecting 0.7% to 20% of patients undergoing standard intra-articular reconstruction. To address this rotational instability, lateral extra-articular tenodesis (LET) techniques have been reintroduced as supplementary procedures alongside standard ACLR [2]. Originally popular before arthroscopic methods, LET procedures, specifically the modified Lemaire technique, have demonstrated potential in improving rotational stability by positioning lateral soft-tissue restraints, enhancing their mechanical control over knee rotation [3]. Although early adoption of arthroscopic ACL reconstruction reduced the use of LET, contemporary clinical observations and biomechanical studies have highlighted LET's role in decreasing the risk of ACL graft rupture by reducing rotational stresses on the reconstructed ligament [4].

Despite promising results, concerns such as joint over-constraint and potential progression to osteoarthritis remain debated topics. However, recent literature indicates minimal supportive evidence for LET leading to osteoarthritis, thereby revitalizing its clinical use as a complementary procedure to ACLR [5]. Considering these dynamics, this study compares the functional outcomes of arthroscopic ACL reconstruction with and without the adjunctive use of LET using the modified Lemaire technique. The research assesses postoperative knee functionality, rotational stability, and patient satisfaction, employing various clinical evaluations and performance-based measures [6,7].

The primary aim of this study is to evaluate and compare the functional outcomes of patients undergoing arthroscopic anterior cruciate ligament reconstruction with and without lateral extra-articular tenodesis using the modified Lemaire technique. The specific objectives include assessing postoperative rotational stability, graft integrity, risk of recurrence, and overall patient-reported functional outcomes.

Materials and Methods

Ethical Approval and Consent

The study was ethically approved by the Institute Ethical Committee, Indira Gandhi Institute of Medical Sciences (IGIMS), Sheikhpura, Patna (800014). All enrolled patients provided written informed consent before participation.

Study Design and Setting

This prospective study was conducted in the Department of Orthopaedics at IGIMS, Patna. The duration of the study was 18 months.

Participants

The study included 60 patients divided into two groups:

- Group A: 30 patients undergoing isolated Arthroscopic Anterior Cruciate Ligament Reconstruction (ACLR).
- Group B: 30 patients undergoing ACLR with additional Lateral Extra-articular Tenodesis (LET) using the modified Lemaire technique.

Inclusion Criteria

- Patients aged between 16-25 years with closed physis.
- Confirmed ACL tear.
- Grade 2 or 3 pivot shift test.
- Hyperlaxity, Beighton score greater than 4.
- Presence of genu recurvatum greater than 10°.
- Patients undergoing revision ACL reconstruction.
- Patients intending to participate in pivoting sports.

Exclusion Criteria

1. Patients older than 25 years.
2. Bilateral ACL tear.
3. Multiple ligament knee injury (MLKI).

4. ACL tear accompanied with lateral compartment osteoarthritis or degenerative arthritis.
5. Loss of follow-up or patients unwilling to provide consent.

Preoperative Procedures

Routine preoperative assessments, including clinical and radiological evaluations, hemoglobin total count, differential count, platelet count, chest X-ray, and ECG, were conducted. Anaesthetic assessment for regional and general anesthesia was completed for each patient. All patients underwent preoperative rehabilitation involving quadriceps strengthening and knee range-of-motion exercises.

Surgical Technique

Patients underwent arthroscopic ACL reconstruction, with a subgroup undergoing additional LET using the modified Lemaire technique. The LET procedure involved harvesting a 1 cm wide and 8 cm long iliotibial band strip from Gerdy's tubercle, which was passed deep to the lateral collateral ligament and secured near the lateral epicondyle using bone staples.

Postoperative Rehabilitation

The rehabilitation protocol was consistent across both groups:

- 0-2 weeks: Emphasis on achieving full knee extension, partial weight-bearing, and basic quadriceps strengthening.
- 2-4 weeks: Progression of range of motion (ROM) up to 120°, full weight-bearing with crutches, and strength training.
- 4-6 weeks: Isokinetic exercises and aquatic therapy.
- 8-10 weeks: Introduction of running and slide board activities.
- 12-16 weeks: Emphasis on gait normalization.
- 5-6 months: Initiation of agility and sports-specific drills.
- Beyond 6 months: Return to sport contingent on achieving ROM of 130°, hamstring strength greater than 90%, and quadriceps strength greater than 85%.

Outcome Assessment

Functional outcomes were assessed using the Tegner-Lysholm knee score, International Knee Documentation Committee (IKDC) score, Lower Extremity Functional Score (LEFS), and P4 Index at 3, 6, 9, and 12 months postoperatively. Additionally, hop tests (single, triple, crossover, and timed 6-meter hops) were conducted at 12 months postoperatively to evaluate limb symmetry (Limb Symmetry Index - LSI).

Patients were followed up regularly to monitor rehabilitation progress, assess functional recovery, and detect any complications or deviations from expected recovery trajectories.

Results

A total of 60 patients participated in this study, equally divided into two groups of 30 patients each: isolated ACL reconstruction (ACLR) and ACL reconstruction combined with lateral extra-articular tenodesis (ACLR+LET). The mean age of participants was 22.73 ± 2.50 years, with a range from 16 to 25 years. In terms of gender distribution, the ACLR group consisted of 90% males and 10% females, whereas the ACLR+LET group included 93.3% males and 6.7% females. Regarding the mode of injury, sports injuries were the predominant cause, accounting for 63.3% of cases across both groups, followed by road traffic accidents (RTA) at 31.7% and other causes at 5.0%.

Functional outcome measures demonstrated significant improvements over time in both groups, with notable differences between the groups. The Lower Extremity Functional Score (LEFS) significantly increased in both groups from baseline to the 12-month follow-up, with the ACLR+LET group showing a greater improvement (73.10 ± 4.47) compared to

the ACLR group (68.57 ± 6.61). Similarly, the Tegner Lysholm score improved significantly in both groups. However, the ACLR+LET group exhibited a more pronounced improvement, rising from a baseline score of 63.77 ± 8.83 to 92.77 ± 5.41 at 12 months, while the ACLR group improved from 63.03 ± 11.95 to 84.03 ± 7.32.

The International Knee Documentation Committee (IKDC) scores also showed significant differences between groups over time, with the ACLR+LET group achieving a higher mean score of 79.03 ± 5.29 at 12 months compared to 72.37 ± 5.99 in the ACLR group. Pain, assessed using the P4 Index, reduced significantly in both groups over the 12 months, with no significant differences between the groups at the final follow-up.

At the 12-month follow-up, the Limb Symmetry Index (LSI), by hop tests (single hop, triple hop, crossover hop, and 6-meter timed hop) revealed significantly better results in the ACLR+LET group compared to the isolated ACLR group, indicating superior functional recovery and stability.

Overall, the ACLR+LET group demonstrated enhanced postoperative functional outcomes and stability compared to the isolated ACLR group across multiple assessment parameters.

Table 1: Age and Gender Distribution

Parameters	ACLR	ACLR + LET
Mean Age (Years)	22.30	23.17
Male (%)	90.0	93.3
Female (%)	10.0	6.7

Table 2: Mode of Injury and Side Distribution

Parameters	ACLR (%)	ACLR + LET (%)
Sports Injury	66.7	60.0
Road Traffic Accident (RTA)	30.0	33.3
Other Injury	3.3	6.7
Right Side	60.0	62.1
Left Side	40.0	37.9

Table 3: Pivot Shift Grade Distribution

Pivot Shift Grade	ACLR (%)	ACLR + LET (%)
Grade 2	57.7	75.0
Grade 3	42.3	25.0

Table 4: Functional Scores at 12 Months

Scores at 12 months	ACLR Mean	ACLR + LET Mean
LEFS	68.57	73.10
Tegner Lysholm	84.03	92.77
IKDC	72.37	79.03
P4 Index	0.80	0.80

Table 5: Hop Test Results at 12 Months (Limb Symmetry Index - LSI%)

Hop Test	ACLR (%)	ACLR + LET (%)
Single Hop	92.18	95.01
Triple Hop	92.87	95.74
Cross Leg Hop	92.37	95.86
6m Distance Time	93.13	95.12

Discussion

This study compared functional outcomes of isolated ACL Reconstruction (ACLR) and ACL Reconstruction combined with Lateral Extra-articular Tenodesis (LET) in 60 patients. Patients receiving ACLR with LET showed significantly better functional scores (LEFS, Tegner Lysholm, IKDC) and superior hop test performance, suggesting enhanced knee stability and rotational control compared to ACLR alone. The demographic data matched prior studies, indicating younger, male-dominated cohorts frequently affected by ACL injuries (Dos Santos et al., 2021). Sports injuries were the predominant cause, mirroring the findings of Meynard et al. (2020), emphasizing sports as a primary ACL injury mechanism [8,9].

Pivot shift test outcomes demonstrated better rotational stability in the LET group. Similar results were reported by Getgood et al. (2020), who observed reduced rotational laxity with LET augmentation [10]. Functional scoring (Tegner Lysholm, IKDC) showed consistent improvement at 12-month follow-ups in the LET group, supporting earlier findings by Sharma et al. (2022) and Meynard et al. (2020). Hop tests further validated the superior limb symmetry index and muscle strength in the LET group, consistent with Jing Feng et al.'s (2022) meta-analysis, highlighting decreased graft failure and improved rotational stability with LET addition [11,12]. This study supports LET augmentation alongside ACLR for improved knee stability, functional recovery, and rotational control, especially beneficial for active individuals involved in pivoting sports. However, further long-term studies with larger samples are necessary to evaluate durability and long-term joint health outcomes comprehensively.

Future studies could enhance this research by addressing several key aspects. Long-term follow-up is essential to better understand the durability of functional improvements observed with combined ACL reconstruction and lateral extra-articular tenodesis (LET). Prospective randomized controlled trials with larger patient cohorts would strengthen evidence regarding the effectiveness and safety of LET augmentation. Further research should also explore patient-specific factors, including anatomical variability, activity levels, and injury severity, to define clearer indications and optimize patient selection criteria for LET. Advanced imaging techniques, such as MRI, could be integrated to evaluate graft integrity, rotational stability, and the progression of osteoarthritis postoperatively. Additionally, biomechanical analyses and comparative cost-effectiveness studies might provide valuable insights, aiding in clinical decision-making and policy development regarding ACL reconstruction procedures.

Conclusion

This study demonstrates that arthroscopic anterior cruciate ligament reconstruction (ACLR) combined with lateral extra-articular tenodesis (LET) significantly improves functional outcomes, rotational stability, and overall knee performance compared to isolated ACLR. The addition of LET resulted in superior LEFS, Tegner Lysholm, and IKDC scores, as well as better performance in hop tests, indicating enhanced functional recovery and knee stability. These findings support the recommendation of LET augmentation alongside ACLR, particularly beneficial for young, active individuals engaging in pivoting sports or activities. However, long-term follow-up studies with larger patient populations are warranted to further confirm these benefits and evaluate their long-term implications on joint health.

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