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Residual rotational instability after ACL reconstruction: is leat the answer for grade 3 pivot shift

[1]Dr Davinder Singh, Direct Professor, Sports Injury Centre, Safdurjung Hospital

[2]Dr Ashu Kumar Meena, Assistant Professor, SIC

[3]Dr Amit Hedge SR, SIC.

[4]Dr Rohit Sherawat, Assistant Professor

Corresponding Author: Dr Ashu Kumar Meena, Assistant Professor, SIC

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Abstract

Introduction: Persistent residual rotational instability has been reported in about 15-35% of cases after ACL reconstruction, demonstrated by a positive pivot-shift test. Therefore, it has been proposed that reconstructive techniques for ACL injuries do not completely restore the normal rotational stability of the knee, despite recent advancements in surgical procedures and knowledge of the architecture and biomechanics of the ACL. Considering the reported variation in combined ACL and Lateral extra-articular tenodesis outcomes, this study assessed the improvement in rotational instability after combined ACL and LEAT.

Methods: The current study analysed 54 patients who had been treated for ACL injuries in the Sports Injury Centre, VMMC&SJH, New Delhi. The clinical evaluation for residual laxity or rotational instability was conducted 12 months post-surgery using the pivot shift test, anterior drawer test, and Lachman test.

Results: The study included 54 patients, out of which 8.78% were female and 92.22% were male. The mean age of the operated patients was 29.14 years (16- 53 years). Of the 54 patients, 16 reported positive for high-grade pivot shift test with positive anterior drawer and Lachman test pre-operatively. The 16 patients operated on for ACL reconstruction and LEAT did not report any 'giving way' complaints and were found negative for pivot shift test post-operatively at follow-up after 12 months. On the other hand, out of 38 patients who underwent isolated ACL reconstruction, 6 patients (15.8%) were found to be positive for pivot shift test post-operatively after 12 months. One of these patients reported graft failure with the complaint of not being able to return to normal activity completely at a follow-up of 12 months.

Conclusion: The data supporting the combined ACL and ALL reconstruction surgeries are limited, low-evidence, and controversial. Such procedures should be customized according to clinical imaging and arthroscopic assessment. This audit may add to the data pool for generating high-quality clinical evidence to opt for combined surgeries over isolated ACL reconstruction.

Keywords: ACL, ALL, LEAT, Pivot Shift Test

Introduction

Sports injury is a major burden in orthopedic practise worldwide, encompassing procedures such as knee ligament reconstruction, including the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), and other collateral ligaments. Among these, ACL reconstruction is the most frequently performed surgery, particularly in young and athletic individuals, to restore natural knee kinematics. (Deviandri and van der Veen 2021). However, persistent residual rotational instability has been reported in about 15-35% of cases after ACL reconstruction, demonstrated by a positive pivot-shift test (Lai, Zhang et al. 2023). Therefore, it has been proposed that reconstructive techniques for ACL injuries do not completely restore the normal rotational stability of the knee, despite recent advancements in surgical procedures and knowledge of the architecture and biomechanics of the ACL. Such residual instability may be a prominent factor in recurring injuries or re-ruptures (Di Benedetto, Di Benedetto et al. 2016, Lai, Zhang et al. 2023) It can also lead to secondary meniscal and cartilaginous issues (Gürpınar, Polat et al. 2018). Thus, revision surgeries are frequently needed as such instabilities make pivoting sports difficult. The anterolateral complex of the knee, particularly the anterolateral ligament (ALL), is hypothesized to control the internal rotation of the knee. Thus, ALL has been studied concerning its anatomy and biomechanics in the past few years (Chambat, Guier et al. 2013, Bonanzinga, Signorelli et al. 2017). Together with the ACL, the ALL has a synergistic influence on regulating the rotational stability of the knee (Lai, Zhang et al. 2023). Furthermore, studies have shown ALL injuries to be present along with ACL tears (Ferretti, Monaco et al. 2019, Helito, Helito et al. 2019, Van Dyck, De Smet et al. 2019). Thus, a combined ACL reconstruction with lateral extra-articular procedures such as ALL reconstruction or lateral extraarticular tenodesis (LEAT) may restore better knee kinematics compared to isolated ACL reconstruction. The combined ACL and ALL restoration also offer protection to the ACL graft and menisci (Sonnery-Cottet, Haidar et al. 2021).

Furthermore, the risks of ACL graft rupture, reoperation, and comorbidities are all significantly decreased with combined ACL and ALL reconstruction (Saithna, Thaunat et al. 2018). Therefore, combining a lateral extra-articular procedure with an intra-articular reconstruction to treat ACL injury emerged, to decrease rotational instability. This combined procedure may prove to be safe and effective and can lead to better clinical and functional outcomes (Sonnery-Cottet, Saithna et al. 2018, Lai, Zhang et al. 2023).

However, some studies have suggested that the simultaneous ALL and ACL knee injuries had little to no impact on rotatory knee laxity or reoperation rates (Thaunat, Clowez et al. 2017, Park, Lee et al. 2019, Lai, Zhang et al. 2023). Thus, the effectiveness of ALL in preventing persistent rotational instability in knees with ACL injuries is still debatable (Sonnery-Cottet, Daggett et al. 2017). Additionally, the pivot shift test is the physical examination most closely associated with

functional outcomes after ACL reconstruction. It is valuable for assessing rotational instability in patients. (Akmese et al. 2021).

Considering the reported variation in combined ACL and LEAT outcomes, this study was undertaken to assess the improvement in rotational instability after combined ACL and LEAT surgeries. It also evaluated its further use in clinical practice, especially for young and athletic individuals.

Methods

The current study analysed 54 patients who had been treated for ACL injuries in the Sports Injury Centre, VMMC&SJH, New Delhi, all of them were operated by the same surgeon.

All patients with clinical and radiological suspicion of an ACL injury with a suspected ALL injury were included in the study. Their clinical records and radiographic findings were reviewed retrospectively. The provisional diagnosis of an ACL injury with a suspected ALL injury was based on clinical symptoms such as pain, instability, and a feeling of giving way, along with clinical signs including a positive Lachman test, anterior drawer test, and grade 3 pivot shift test. Radiological findings, such as Segond's fracture on plain X-ray, also contributed to the diagnosis. Further, the patients reported anterolateral bony edema in the proximal tibia in an acute stage, and significant lateral impact on lateral femoral condyle on magnetic resonance imaging findings.

The inclusion criteria of the ACL injury patients were young age, participation in pivoting sports or a high-demand athlete, evidence of a pivot shift on examination, evidence of a lateral femoral notch sign on preoperative imaging, and Segond fracture. Patients with lateral compartment arthritis, posterolateral corner injury, posterior cruciate ligament tear, previous knee surgery, revision surgeries, trauma, infection, and multiligamentous injury, were excluded from the study.

After the informed and written consent for surgery, all patients underwent surgery with the completion of all surgical formalities. The pivot shift examination was done under anesthesia pre-operatively and patients with grade 3 pivot shift test were included for combined ACL reconstruction with LEAT. Patients with grade 1/2 pivot shift were included for isolated ACL reconstruction. The combined surgery involved the use of a short autologous iliotibial band (ITB)-strip fixed proximally at the anatomic femoral origin of the ALL, which does not interfere with the anatomy and function of the lateral collateral ligament (Stuyts, Van den Eeden et al. 2017). The clinical evaluation for residual laxity or rotational instability was conducted at 12 months post-surgery using the pivot shift test, anterior drawer test, and Lachman test (Evans and Neilson 2022). Moreover, postoperative complications were also reviewed for all the patients.

Clinical Examination

Pivot shift test: It included knee flexion from 0º to 90º along with external rotational stress to the tibia and valgus stress to the knee (Vaudreuil, Rothrauff et al. 2019). The subluxated tibia reduced during knee flexion with the subjective sensation of the reduction was used to grade the pivot shift as per the International Knee Documentation Committee (IKDC). A locked subluxation of tibia observed was considered positive as high grade pivot shift. The grading was conducted as normal (grade 0), glide (grade 1), clunk (grade 2) and locked subluxation (grade 3)

Anterior Drawer test: The hip and knee were flexed at 45º and 90º, respectively with the patient in the supine

position. The proximal tibia was repeatedly subjected to gentle anterior-posterior stresses while the foot was secured to the examination table and the hamstrings were relaxed. The anteroposterior displacement of the tibia in the flexed knee was then measured. The displacement was measured and compared with the normal side (Makhmalbaf, Moradi et al. 2013). Positive test was indicated when displacement of more than 10 mm was observed comparing one side to a soft end point.

Lachman test: The knee is bent at 15º and rotated slightly externally with the patient in the supine position. The proximal tibia is then dragged forward with femur being stabilized with one hand. The other hand is placed behind the proximal tibia at the level of the joint line. An anterior movement should be consistently restrained in a normal response (Makhmalbaf, Moradi et al. 2013). Anterior displacement of the proximal tibia felt by the examiner's thumb in a soft or mushy end point indicated positive test. Displacement of >10 mm compared with the contralateral knee was considered for this audit as positive

Surgical Procedure

Arthroscopic ACL reconstruction is done in standard manner with accurate tunnel positions.

Position the leg with the knee at approximately 80° of flexion. Make a longitudinal incision of at least 6 cm, positioned 1 cm posterior to the lateral femoral epicondyle and extending from 2 cm proximal to Gerdy's tubercle. If enhanced visualization is necessary, especially in patients with significant subcutaneous tissue, extend the incision proximally. Dissect through the subcutaneous fat down to the iliotibial band (ITB), sweeping the fat posteriorly to expose the posterior border of the ITB. This allows for palpation of Gerdy's tubercle distally.

Figure 1:

Figure 2:

Harvest an 10 cm long and 1 cm wide strip from the posterior half of the iliotibial band (ITB), ensuring that the deepest posterior fibers of the capsulo-osseous layer remain intact. Keep the distal attachment at Gerdy's tubercle preserved. Release the deep attachments to the vastus lateralis along the proximal 6 cm of the graft and secure it with a whipstitch.

Figure 3:

Make small capsular incisions both anterior and posterior to the proximal portion of the LCL. Insert scissors deep to the LCL from anterior to posterior, using blunt dissection to create a tract for graft passage. The free end of the ITB strip is passed below the LCL from distal to proximal in the extracapsular plane. Locate the proximal attachment site just anterior and proximal to the lateral head of the gastrocnemius tendon, on the lateral metaphyseal flare of the lateral femoral condyle. Exercise caution to prevent damage to the ACL femoral fixation, as the suspensory loop button is often positioned nearby. Then the strip of ITB passed through the tunnel made at the distal femur. It can be fixed with an interference screw or suture anchor.

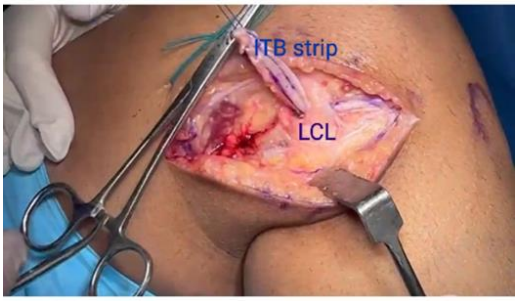


Figure 4:

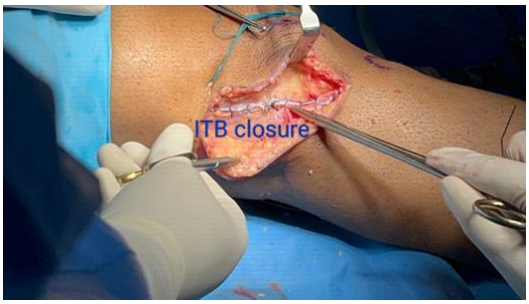


Figure 5:

Hold the graft taut, ensuring it is not over-tensioned (<20 N) while maintaining the knee at 60° of flexion and the foot in a neutral rotation to prevent over constraint of the lateral compartment. Close the posterior aspect of the ITB with interrupted sutures up to the level of the transverse retinacular ligament. Incision to be closed in layers.

Post-Operative Rehabilitation: It was done according to the standard institutional protocols.

0-2 weeks

Patellar mobilisation

Isometric quadriceps sets

Straight leg raising with brace

Prone knee hangs

Passive and active assisted knee range of motion

Wall and sitting slides

Electrical stimulation if required

Partial weight bearing with crutches and long knee brace

2-4 weeks

Progress straight leg raising

Prone and standing hamstring curls with weights

Full weight bearing with crutches

Double leg press with lightweight

Wall sits

Treadmill with emphasis on normal gait

4-6 weeks

Progress to full ROM by 6 weeks

Isokinetic quadriceps and hamstring strengthening

Progress closed chain exercises

8-12weeks

Progress above listed exercises

Slow running

Isokinetic quadriceps with different speeds

Begin fitter and slide boards

Full range isotonics

5-6 months

Agility training

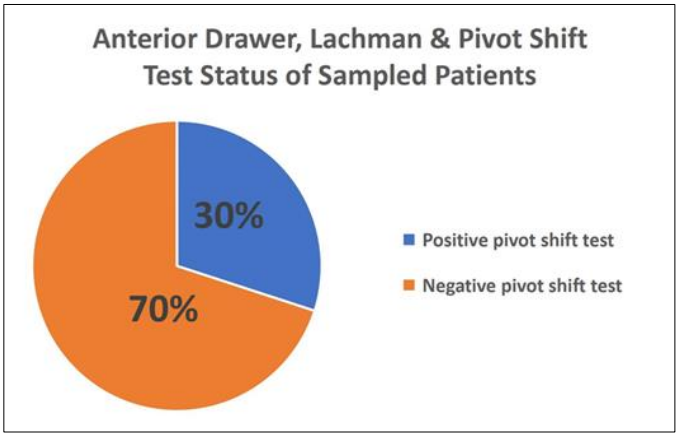
Sport-specific drills

At 6 months return to sports is assessed and strengthening exercises will progress

Results

The study included 54 patients, out of which 7.78% were female and 92.22% were male.

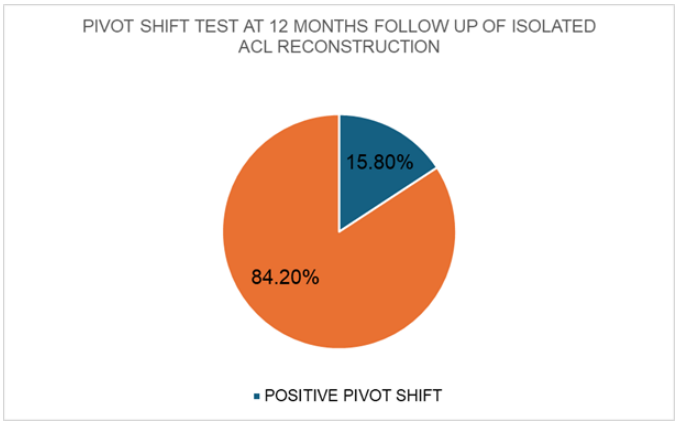
The mean age of the operated patients was 29.14 years (16- 53 years). Of the 54 patients, 16 reported positive for high-grade pivot shift test with positive anterior drawer and Lachman test pre-operatively (Figure 1). These patients underwent combined ACL and LEAT. The remaining 38 patients were positive for only the anterior drawer and Lachman test and negative for the pivot shift test pre-operatively. They were operated on for isolated ACL reconstruction.



Graph 1: Preoperative status of patients who underwent combined ACL and ALL reconstruction

The 16 patients operated on for ACL reconstruction and LEAT did not report any 'giving way' complaints and were found negative for pivot shift test post-operatively at follow-up after 12 months.

On the other hand, out of 38 patients who underwent isolated ACL reconstruction, 6 patients (15.8%) were found to be positive for pivot shift test post-operatively after 12 months. One of these patients reported graft failure with the complaint of not being able to return to normal activity completely at a follow-up of 12 months.



Graph 2: Postoperative status of patients who underwent isolated ACL reconstruction at 12 months

Discussion

One of the most frequent sports injuries to the knee is ACL tear, and a substantial proportion of all knee ligament procedures involve ACL reconstruction (Gianotti, Marshall et al. 2009). Traditionally, young and athletic patients with ACL injuries who wanted to participate in pivoting sports underwent ACL reconstruction surgeries to restore rotatory and anterior-posterior knee stability (Yin, Yang et al. 2021). However, since rotational instability was still observed in many patients, it led to the failure of ACL reconstruction surgeries, and they had to undergo revision surgeries. Later, several factors affecting rotational instability were identified, and the anatomical and biomechanical role of ALL was identified and explored (Chambat, Guier et al. 2013, Claes, Vereecke et al. 2013, Syam, Chouhan et al. 2017). When the ACL and ALL other structures were injured at the same time with a positive pivot shift, a standalone ACL restoration could not restore normal knee kinematics (Guenther, Irarrázaval et al. 2017). Patients undergoing ACL revision surgeries, high-grade positive pivot shift testing, recurrent ACL ruptures, adolescents with involvement in pivoting sports, and medial meniscus repair are some of the indications when ALL restoration

surgeries are now recommended. In addition, anatomic restoration of ALL with minimally invasive procedures to treat anterolateral rotatory instability can produce better outcomes without complications (Sonnery-Cottet, Vieira et al. 2019).

Thus, combined ACL and LEAT surgeries were adopted by many surgeons to maintain rotational instability. Several reports in the literature suggest better outcomes in terms of rotational instability with combined surgery than isolated ACL reconstruction surgery. Sonnery-Cottet et al (Sonnery-Cottet, Thaunat et al. 2015) suggested the combined surgery to be an effective procedure with lower graft failure rates in a retrospective study of 92 patients. A recent randomized controlled trial on 57 ACL injury patients found a significant difference in postoperative pivot shift tests among patients undergoing combined surgery versus patients undergoing isolated ACL reconstruction. At the end of one year, better outcomes were observed in the combined surgery patients for rotational instability for athletic patients with positive pivot shift test (Mogoş, D'Ambrosi et al. 2023). A large prospective comparative series of 502 ACL reconstructions with a minimum follow-up of 2 years demonstrated significantly reduced rates of ACL graft tear in a high-risk population (young patients participating in pivoting sports) after combined ACL and ALL reconstruction compared with a matched cohort undergoing isolated ACL reconstruction with hamstring or patellar tendon graft (Sonnery-Cottet, Saithna et al. 2017). Further, a systematic review and meta-analysis of 46 articles also demonstrated the superiority of combined surgery over isolated one with respect to internal stability, anterior translation, pivot shift, and failure rates (Kunze, Manzi et al. 2021).

However, Ibrahim et al (Ibrahim, Shohdy et al. 2017) conducted a trial on 110 ACL injury patients with positive pivot shift tests. The authors could not find any superiority of combined ACL and LEAT to isolated ACL surgery and suggested that combined surgery should not be a routine procedure for all ACL injury patients. Furthermore, another systematic review and meta-analysis of 6 studies indicated that combined ACL and LEAT should not be a standard procedure but should be preserved for patients with chronic rotatory stability issues (Rhatomy, Ariyanto et al. 2022).

A recent systematic review and meta-analysis of 14 studies also suggested combined ACL and ALL reconstruction surgery be better in terms of anteroposterior and anterolateral rotational stability and failure rates than isolated ACL reconstruction. Therefore, the authors recommended combined surgery, especially in athletic patients involved in pivoting (Lai, Zhang et al. 2023).

Techniques for extra-articular ligament reconstruction that target the ALL may give the knee rotational stability and restore function (Stuyts, Van den Eeden et al. 2017). A meta-analysis of 8 randomized trials showed that a combined lateral extra-articular tenodesis (LEAT) targeting ALL and intra-articular ACL reconstruction improved pivot shift (Hewison, Tran et al. 2015). Thus, in this study, we tried to evaluate the effectiveness of combined ACL and LEAT using ITB strip to improve rotational instability compared to isolated ACL injury using the same technique. The anterior drawer test, Lachman test, and pivot shift are 3 historical tests that are used to diagnose ACL tears. The anterior drawer test possesses less sensitivity for detecting acute ACL tears, while the Lachman test is more reliable and unbiased for assessing laxity

following ACL reconstruction (Yin, Yang et al. 2021, Zhao, Lyu et al. 2021). Further, the pivot-shift test is the most significant indicator of stabilizing the knee joint's rotation (Yin, Yang et al. 2021). In this study, we assessed the patients physically pre-operatively and post-operatively using these 3 tests.

The results at our center found a reduction in pivot shift, suggesting better rotational stability in patients who underwent combined ACL and LEAT compared to isolated ACL surgery.

Lessons learned and recommendations

The surgical practice at our center has been reformed after this study to attain better clinical outcomes for ACL injury patients. Though isolated ACL reconstruction was done in patients without high-grade pivot shift, positive pivot shift and instability persisted at 12 months post-surgery, maybe because of the contact sports they play, younger age or hyperlaxity which again emphasizes on considering anterolateral reconstruction on patients factors in all cases. This may be because of lesser grade pivot shift causing anterolateral instability in these patients. We suggest continuing the long-term follow-up of patients operated on for combined ACL with LEAT and collecting quality evidence to support its role in chronic rotatory instability issues in knees. We intend to re-evaluate our procedures in the future.

Conclusion

The data supporting the combined ACL and LEAT are limited, low evidence, and controversial. Such procedures should be customized according to clinical imaging and arthroscopic assessment. This study may add to the data pool for generating high-quality clinical evidence to add LEAT to isolated ACL reconstruction whenever required.

Abbreviations

ACL – Anterior cruciate ligament

ALL – Anterolateral Ligament

LEAT – Lateral extra-articular tenodesis

LCL – Lateral collateral ligament

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