

Difference in Functional Outcomes Between Anterior Cruciate Ligament (ACL) Reconstruction Combined with Lateral Extra-Articular Tenodesis (LEAT) and Without LEAT Combination for ACL Injury Patients in the Third and Sixth Months Postoperative

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ABSTRACT

Introduction: Anterior Cruciate Ligament (ACL) rupture is a common knee injury, particularly affecting young, active individuals. Reconstruction techniques for ACL injury, with or without Lateral Extra-Articular Tenodesis (LEAT), play a crucial role in determining patient outcomes. This study aims to compare the functional outcomes of ACL reconstruction with LEAT and without LEAT.

Materials and Methods: This retrospective cohort study was conducted from February 2023 to February 2024 at Prof. IGNG Ngoerah Hospital, involving 40 patients who underwent ACL reconstruction (18 with LEAT, 22 without LEAT). Patient outcomes were evaluated at 3, 6, and 12 months postoperatively using IKDC, Tegner, KOOS scores, and Rolimeter measurements. Statistical analysis included chi-square and independent t-tests to assess differences between the two groups.

Results: The baseline characteristics showed no significant differences between

the groups, indicating no confounding factors. Males comprised 67.5% of the cohort, with the majority (72.5%) aged 18-30 years, and 57.5% were private sector employees. The most common injury mechanism was sports-related (50%). The most prevalent symptom was knee pain (52.5%). Statistically significant improvements were observed in the LEAT group compared to the non-LEAT group in KOOS, IKDC, and Rolimeter scores at both 3 and 6 months ($p < 0.001$).

Conclusion: ACL reconstruction with LEAT demonstrated superior clinical and functional outcomes compared to reconstruction without LEAT, suggesting that this technique may provide enhanced stability, especially for athletes and individuals engaging in pivot-heavy activities.

Keywords: ACL reconstruction, Lateral Extra-Articular Tenodesis, functional outcomes, knee injury, sports medicine

INTRODUCTION

Anterior Cruciate Ligament (ACL) rupture is a severe knee injury, particularly common among active, younger individuals, leading to disruptions in physical activity. While ACL reconstruction is a standard treatment, outcomes are often unsatisfactory, necessitating additional techniques for managing rotational instability. One such technique is combining ACL reconstruction with Lateral Extra-Articular Tenodesis (LEAT), though the effectiveness of this combined approach remains under investigation. ACL injuries are prevalent, with approximately 200,000 cases annually in the U.S., leading to 100,000 ACL reconstructions each year (Biau, 2006). ACL ruptures are typically characterized by knee instability, pain, and symptoms like "giving away" or locking, resulting in proprioceptive dysfunction, muscle weakness, and diminished knee performance. Without treatment, ACL injuries can lead to early osteoarthritis (Froebel, 2010).

ACL reconstruction has traditionally been performed through open surgery, but more recently, arthroscopic techniques have gained popularity (Romanini et al., 2010). The reconstruction procedure has sparked debates, particularly concerning graft selection (autograft vs. allograft) and additional ligament reconstructions, such as LEAT, which is suggested to help with rotational instability (Tulloch, 2019). LEAT reconstruction can prevent recurring injuries and early osteoarthritis by stabilizing the knee joint (Eufemio, 2010). Postoperative evaluation typically uses tools like the International Knee Documentation Committee (IKDC), KOOS, Tegner Activity Scale, and objective tools like Rolimeter to assess knee laxity (Moll & Deie, 2020; Kocadal et al., 2020).

Studies show that combining LEAT with ACL reconstruction reduces graft failure rates and improves outcomes by stabilizing rotational laxity (Grassi et al., 2019). The Lemaire LEAT technique, involving

iliotibial band grafts, has been shown to reduce knee instability, especially for athletes (Deviandri, 2021). Research by Getgood et al. (2019) also supports the efficacy of LEAT in reducing ACL graft failure rates post-reconstruction. While ACL reconstruction is common, issues like persistent instability and suboptimal outcomes remain, especially in high-activity populations. Thus, combining LEAT with ACL reconstruction may offer a more effective solution for these challenges (Pavlik, 2006). However, studies comparing ACL reconstructions with and without LEAT are still lacking, highlighting the need for further research on this approach.

MATERIALS & METHODS

The design of this study is a cohort retrospective study that seeks to investigate the relationship between variables to assess the subjective and objective functional outcomes of ACL reconstruction procedures with and without LEAT. This research will be conducted from February 2023 to February 2024. The ACL reconstruction procedures for patients with ACL injuries will be performed at RSUP Prof. Ngoerah Denpasar. Evaluations based on IKDC, Tegner, KOOS scores, and Rolimeter examination will be carried out at the Orthopaedic outpatient clinic of RSUP Prof. dr. IGNG Ngoerah Denpasar, at 3 and 6 months postoperatively.

Patient Selection

The inclusion criteria for this study, as outlined by Beckers (2021), are as follows: patients with a complete anterior cruciate ligament (ACL) rupture confirmed by MRI, positive pivot-shift test, positive Lachman test, and positive anterior drawer test at 90 degrees. All surgeries were performed by the same surgical team, and participants were under 40 years old. Exclusion criteria include patients with a partial ACL tear, a history of ACL reconstruction surgery, multi ligament injuries involving more than two ligaments, asymmetric varus deformity

exceeding 3 degrees, ligament laxity confirmed by the Beighton Hypermobility Score, or unwillingness to adhere to follow-up for up to 12 months postoperatively.

Data Extraction

The characteristics, demographics, and results of objective and subjective measurements are compiled and presented in a master table manually. The data summarized in the master table is then divided into two groups: the ACL with LEAT combination group and the ACL without LEAT group. Once the data is grouped, analysis is conducted.

Data Analysis

Data collection was organized into tables using Microsoft Excel. Statistical data processing was conducted using SPSS version 29. Descriptive data of the research sample characteristics were presented as means and standard deviations (SD) for numerical data, and as frequencies (n) and percentages (%) for categorical data. Basic sample characteristics were analyzed

descriptively, and differences in proportions of basic characteristics were assessed using the chi-square test. Data normality was evaluated using the Shapiro-Wilk test due to the sample size being fewer than 50. For statistical tests, an independent t-test was used for parametric/normally distributed numerical variables, while non-parametric/non-normally distributed data were analyzed using the Mann-Whitney U test.

RESULT

This study included data from 40 patients with ACL rupture who underwent ACL reconstruction surgery from February 2023 to February 2024 at RSUP Prof. Dr. I.G.N.G. Ngoerah, Denpasar, Bali. Patients were divided into two groups: 18 underwent ACL reconstruction with LEAT, and 22 without LEAT. Most were male (67.5%), aged 18–30 years (72.5%), private employees (57.5%), with sports injuries (50%) or motor accidents (47.5%) as common causes (Table 1).

Table 1. Patients Characteristics

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	27	67.5
	Female	13	32.5
Age	< 17 year	2	5
	18-30 year	29	72.5
	31-65 year	9	22.5
Occupation	Student	5	12.5
	Undergraduate	10	25
	Private employee	23	57.5
	Others	2	5
Mechanism of Injury	Motorcycle accident	19	47.5
	Car accident	1	2.5
	Sports	20	50
Symptom	Recurrent injury	1	2.5
	Knee pain	21	52.5
	Instability	18	45

This study compared functional outcomes between patients undergoing ACL reconstruction with and without Lateral Extra-Articular Tenodesis (LEAT) at three and six months postoperatively. Statistical analyses revealed significant differences

favoring the LEAT group across various measures (Table 2).

The KOOS scores, assessed through independent t-tests, were significantly higher in the LEAT group at both three and six months ($p < 0.001$), indicating improved

knee function, including pain reduction, daily activity, and sports-related performance. Similarly, the IKDC Knee Scores were higher in the LEAT group at three months ($p < 0.001$) as shown by independent t-tests, while non-parametric Mann-Whitney tests demonstrated significantly higher ranked IKDC scores in the LEAT group at six months ($p < 0.001$), confirming sustained functional improvement (Table 2).

Return-to-activity levels, measured using the Tegner activity scale, also showed statistically significant differences between the two groups. Non-parametric Mann-

Whitney tests revealed higher ranked Tegner scores in the LEAT group at both three and six months ($p < 0.001$), suggesting better recovery and readiness for high-level physical activities in patients undergoing ACL reconstruction with LEAT (Table 2).

Knee laxity, as evaluated by Rolimeter measurements, showed significant improvements in the LEAT group. Mann-Whitney tests indicated lower ranked Rolimeter values in the LEAT group compared to the non-LEAT group at three and six months ($p < 0.001$), reflecting reduced anterior tibial translation and enhanced knee stability (Table 2).

Table 2. Outcome Analysis

Outcome	ACL reconstruction with LEAT n=18 (Mean ± SD)	ACL reconstruction without LEAT n=22 (Mean ± SD)	P-value
KOOS			
3 month	68,00±2,32	59,95±6,09	<0,001
6 month	71,00±2,54	57,64±5,79	<0,001
IKDC			
3 month	63,06±4,11	56,59±5,11	<0,001
6 month	70,00 (67-74)	64,50 (61-73)	<0,001
Tegner Score			
3 month	5,00 (4-7)	4,00 (3-6)	<0,001
6 month	7,00 (6-8)	5,50 (4-7)	<0,001
Rolimeter values			
3 month	3,65 (3-4)	5,60 (4-6)	<0,001
4 month	3,50 (3-4)	5,35 (3-6)	<0,001

DISCUSSION

This study found that patients undergoing ACL reconstruction with LEAT had higher average KOOS compared to those without LEAT at three months post-surgery. A statistically significant difference in KOOS scores was observed between the two groups ($p < 0.001$). Similar studies have reported varying results regarding KOOS outcomes in patients undergoing ACL reconstruction with and without LEAT. Research by Getgood et al. showed that adding LEAT to ACL reconstruction reduces graft failure risk and enhances rotational knee stability. Patients with LEAT demonstrated significant improvement in KOOS scores, particularly in the symptom and sports function subscales, with preoperative scores

averaging 55–60 and postoperative scores significantly improving ($p = 0.03$). Similarly, Monaco et al. reported better outcomes in the LEAT group, with a mean difference of 3.8 ($p < 0.05$). Meanwhile, Long-term research by Sonnery-Cottet et al. found that after 5–10 years, patients with LEAT had better KOOS outcomes in the knee-related quality-of-life subscale, with significant postoperative improvements ($p = 0.02$). These findings suggest that LEAT may provide both short- and long-term functional benefits, particularly in reducing re-injury risks and preserving cartilage integrity (Getgood et al., 2019; Monaco et al., 2022; Sonnery-Cottet et al., 2022). Furthermore, this research revealed that the average KOOS score at six months post-surgery was higher in patients undergoing

ACL reconstruction with LEAT compared to those without LEAT. A statistically significant difference in KOOS scores was observed between the groups ($p < 0.001$). However, Rowan et al. found no significant differences in KOOS scores between the two groups after two years post-surgery. Preoperative KOOS scores averaged 50–65, with no significant postoperative differences ($p = 0.12$). LEAT may offer better stability in patients with hyperlax knees or concurrent medial collateral ligament injuries, suggesting its benefits may be specific to certain patient subgroups (Rowan et al., 2019).

This research also found that the mean IKDC Knee Score at three months post-surgery was significantly higher in patients undergoing ACL reconstruction with LEAT compared to those without LEAT ($p < 0.001$). Patients with LEAT showed better outcomes on the IKDC subjective knee form, emphasizing the functional benefits of LEAT addition. This finding aligns with recent studies. Zaffagnini et al. reported that patients undergoing ACL reconstruction with LEAT achieved better IKDC scores than those undergoing standard ACL reconstruction. LEAT improved rotational knee stability and reduced graft failure rates, with preoperative IKDC scores averaging 65–70 and postoperative scores significantly increasing ($p = 0.02$) (Zaffagnini et al., 2017). Song et al. also demonstrated that LEAT improved IKDC scores at a 2-year follow-up, with preoperative scores averaging 60–65 and significant postoperative improvements ($p = 0.03$). LEAT addressed abnormal knee rotation that standard intra-articular ACL reconstruction often fails to control (Song et al., 2016).

Meanwhile, the mean IKDC Knee Score ranking at six months post-surgery was significantly higher in patients undergoing ACL reconstruction with LEAT compared to those without LEAT ($p < 0.001$). Functional outcomes on the IKDC subjective knee form were notably better in

the LEAT group. Current evidence suggests that LEAT provides additional benefits in knee stability and long-term functional outcomes, though results vary based on patient populations and study designs. Decisions to include LEAT should consider individual patient risk profiles and the need for added stability, especially for those at high risk of reconstruction failure (Castoldi et al., 2020; Song et al., 2016). However, not all studies demonstrate clear benefits of LEAT. El-Azab et al. reported no significant differences in IKDC scores between groups after five years ($p = 0.465$), suggesting that while LEAT may offer short-term stability, its long-term functional impact is less pronounced (El-Azab et al., 2023).

Another result from this study revealed that the mean Tegner score at three months post-surgery was significantly higher in patients undergoing ACL reconstruction with LEAT compared to those without LEAT ($p < 0.001$). Functional outcomes measured by the Tegner activity scale showed a notable improvement in the LEAT group, particularly in returning to high-level physical activities. This aligns with Ibrahim et al., who reported that patients with LEAT achieved higher Tegner scores than those undergoing standard ACL reconstruction. LEAT facilitated a return to physically demanding sports like soccer and skiing, with preoperative Tegner scores averaging 4–5 and significant postoperative improvement ($p = 0.02$) (Ibrahim et al., 2017). Furthermore, this study also revealed that the mean Tegner score at six months post-surgery was higher in patients undergoing ACL reconstruction with LEAT compared to those without LEAT. The difference in Tegner scores between the two groups at six months was statistically significant ($p < 0.001$), suggesting improved functional outcomes in the LEAT group. However, Vadalà et al. reported no significant difference in Tegner scores between the LEAT and non-LEAT groups three years postoperatively. Preoperative

Tegner scores averaged 3–4, and postoperative improvements were not statistically significant ($p = 0.12$). The study concluded that while LEAT may provide short-term stability benefits, its impact on long-term physical activity may be limited, influenced by factors like postoperative rehabilitation methods and patient adherence (Vadalà et al., 2013). Deviandri et al. highlighted that LEAT significantly improved Tegner scores only in highly active patients. For this subgroup, preoperative scores averaged 4–5, with significant postoperative gains ($p = 0.05$). Conversely, less active patients showed no notable improvement, suggesting LEAT's benefits are more pronounced in those requiring additional stability (Deviandri et al., 2021). Long-term findings by Gerfroit et al. indicated that after 5 years, patients with LEAT maintained higher Tegner scores. Preoperative scores averaged 3–4, with significant postoperative increases ($p = 0.01$), emphasizing LEAT's role in preserving physical activity and reducing reinjury risk (Gerfroit, 2024).

This study also demonstrated that the average Rolimeter scores at three and six months post-ACL reconstruction were significantly lower in patients with LEAT compared to those without LEAT ($p < 0.001$), indicating better knee stability. Lachmeter measurements, assessing anterior tibial displacement relative to the femur, showed improved rotational and anteroposterior stability with LEAT, consistent with prior studies. Noyes et al. reported that patients with LEAT demonstrated a significantly lower Lachmeter score postoperatively, with a mean anterior displacement of 2 mm compared to 4 mm in the non-LEAT group ($p = 0.01$). This supports LEAT's role in enhancing knee stability, particularly in patients prone to instability (Noyes et al., 2017). Ferretti et al. found similar results; one-year follow-up showed anterior displacement of 1.7 mm in the LEAT group versus 3.5 mm in the non-LEAT group ($p =$

0.02), highlighting LEAT's short- to mid-term advantages (Ferretti et al., 2018). Getgood et al. emphasized LEAT's benefits for patients with hyperlaxity, with anterior displacement averaging 2 mm postoperatively versus 4 mm in non-LEAT patients ($p = 0.03$). This underscores LEAT's utility for those at high risk of knee instability (Getgood et al., 2019). Long-term findings by Monaco et al. showed that LEAT provided sustained stability, with a five-year follow-up revealing 1.8 mm displacement in the LEAT group compared to 3 mm in the non-LEAT group ($p = 0.04$). Patients reported greater satisfaction and reduced reinjury rates (Monaco et al., 2022). Overall, these findings confirm LEAT's efficacy in improving Lachmeter scores and enhancing knee stability, particularly in high-risk populations, making it a valuable addition to ACL reconstruction.

CONCLUSION

Based on this research, ACL reconstruction combined with LEAT shows better outcomes compared to ACL reconstruction without LEAT. Specifically, ACL reconstruction with LEAT resulted in higher IKDC, KOOS, and Tegner scores at both three and six months postoperatively. Additionally, it demonstrated lower laxity scores at both time points compared to the non-LEAT group. These findings suggest that LEAT enhances knee stability and functional outcomes following ACL reconstruction.

Declaration by Authors

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