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Comparative study between combined anterior cruciate ligament reconstruction with anterolateral ligament reconstruction and anterior cruciate ligament reconstruction with lateral extra articular tenodesis

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Abstract

The Anterolateral ligament (ALL) has brought renewed attention to the main mechanism that limits the rotational instability of the knee following an ACL injury. ACL rips are frequently seen in sports-related activities. Various surgical methods have been created to enhance the functional stability of the injured knee, reduce damage to the articular cartilage and meniscus, and enable athletes to resume their previous level of sporting activities after an ACL injury. Study aim to evaluate and compare the functional outcome of patients who were diagnosed to have (ACL) injury in high demanding knees and underwent arthroscopic (ACLR) in combination of anterolateral ligament reconstruction (ALLR) versus lateral extra articular tenodesis (LET). This was a prospective randomized controlled study included a total of 60 patients presenting with ACL injury at Minya University Hospital from January 2019 to March 2023. Age, sex, and other demographic variables did not show any statistically significant differences across the groups. Sports Activity, ASA Physical State, Mechanism of Injury, side, Dominance, Time Since Injury, follow-up duration, Lachman and pivot shift test preoperatively, or postoperatively at 3-, 6-, 12-, 24-, and 36-month follow-up, preoperative and postoperative ROM, Lysholm score at different follow-up intervals and IKDC score and Complications. (ACL) reconstruction combined with either anterolateral procedures (ALLR) or (LET) were safe and effective in the treatment of ACL injury in high demanding knees. ACLR combined with ALLR resulted in better rotational stability and functional outcomes in long-term follow-ups, and associated with lower incidence of complications compared to LET procedure.

Keywords: Arthroscopic anterior cruciate ligament, Anterolateral ligament reconstruction, Lateral extra articular tenodesis.

Full length article **Corresponding Author*, e-mail: Dr.deef@yahoo.com

1. Introduction

The repair of torn anterior cruciate ligaments is a common procedure performed by orthopedic surgeons across the globe. Statistically, yearly ACL repairs in the US are expected to surpass 200,000 [1]. Several investigations on human anatomy have shown that a healthy ACL has three main components: the anteromedial (AM) and posterolateral (PL) bundles, and some have even found an intermediate bundle. The anterior-medial (AM) and posterior-lateral (PL) bundles are the primary sources of knee stability in the anterior-posterior and rotational directions, respectively, according to biomechanical studies [2]. Double-bundle ACL reconstruction is suggested as a method to restore the two-bundle structure of the original ACL. The utilization of the double bundle procedure may enhance the visual aspect of the ACL bundle. However, it also results in an increase in the duration of the surgery due to the need to drill a greater number of tunnels, place the tunnels, and manage the intricate process of passing and fastening the two grafts. Furthermore, it is established that 6% of reconstructions will experience re-rupture, with an equal likelihood of occurrence in the opposite knee. The presence of two tunnels in the femur may result in bigger empty spaces in the lateral femoral condyle that need to be filled during revision surgery [3]. The contemporary intra-articular anatomical anterior cruciate ligament reconstruction (ACLR) has yielded highly satisfactory outcomes for the majority of patients. Nevertheless, there exists a subset of individuals who still experience persistent rotational instability as a concern [4]. Residual rotational instability, which is assessed subjectively as a positive pivot shift, is believed to be a contributing factor to recurring ACL injuries. This instability might persist in around 25% of patients following single-bundle ACLR. In theory, the inclusion of the lateral extra-articular tenodesis (LET) is crucial for more effectively limiting the movement of the lateral tibial compartment and enhancing the leverage

for managing the rotational looseness of knee joints [6]. This study set intended to compare and contrast the functional outcome of patients with an ACL damage in knees that are subjected to high levels of physical strain. These patients were treated with arthroscopic anterior cruciate ligament reconstruction (ACLR) in conjunction with lateral extra articular tenodesis (LET) or anterolateral ligament reconstruction (ALLR).

2. Patients and methods

From January 2019 to March 2023, The purpose of this prospective randomized controlled trial was to compare the functional outcomes of two surgical procedures for arthroscopic single bundle ACL reconstruction: one using the modified Lemaire technique and the other using ALL reconstruction for 60 patients with high-demand knees who had previously been diagnosed with an ACL injury. Patients reviewed in our Minya University Hospital. A total of 60 patients presenting with ACL injury were enrolled in our study. Patients were divided into two groups: **Group A:** included 30 patients who received arthroscopic ACL repair using a single bundle in combination of ALL reconstruction and **Group B:** The study involved 30 patients who had arthroscopic single bundle ACL repair and lateral extraarticular tenodesis.

2.1 Inclusion criteria

The following criteria must be met in order for a patient to be considered for conservative treatment: they must be physically active and between the ages of 18 and 40, have completed the acute inflammatory phase of their injury, have full range of motion, no extensor lag, and a positive Pivot Shift test of 2 or 3. Additionally, they must not be unwilling to make lifestyle changes.

2.2 Exclusion criteria

Physical unfitness resulting from concurrent comorbidities, Fractures of the lower limbs and/or spine, as well as injuries to the nerves and blood vessels, that are connected or related. Injuries that are related to other ligaments or involve the meniscus of the knee, Manifestations of a local skin infection, alterations in the tibial slope, and reduced flexibility in the knee joint. Patients were subjected to the following: Pre-operative evaluation, Random selection of patients, Rehabilitation program and Follow-up evaluation.

2.2.1 Surgical technique for single bundle ACL reconstruction with anterolateral ligament reconstruction

2.2.1.1 Surgical Technique: Diagnostic Arthroscopy, Graft harvest and preparation, Passage and Fixation of ALL Graft

The gracilis muscle suture is threaded through the posterior bone tunnel, which is situated beneath the iliotibial band and lateral collateral ligament, using an arthroscopy grasper. Using the loop suture, the material is moved posteroanteriorly through the tibial bone tube. After inserting the arthroscopic grasper under the iliotibial band, the gracilis graft is drawn back through the proximal incision and attached to the ACL suture. Do this while keeping your knee completely bent and in a neutral rotation. The next step is to re-tie the sutures that held the ACL graft once the knee is fully extended and in a neutral rotational position. The sutures are then wrapped around the ALL graft. After extending the knee to its maximum range of motion, the excess suture and graft are cut.

2.2.2 Surgical technique for single bundle ACL reconstruction with (extra articular tenodesis (modified lamair)

2.2.2.1 Graft preparation, Harvesting and preparing the ITB band, Femoral and tibial tunnels preparation, ACL Graft Passage and Tibial Fixation, Femoral tunnel and fixation of ITB graft

Prior to attachment to the distal femur, the prepared ITB graft should be carefully threaded under the lateral fibular collateral ligament (LFCL), ensuring that the fibular collateral ligament and underlying capsule are not disturbed. (Figure). The location where the ITB graft is attached must be identified and prepped. The ITB graft should be secured at a position that is 5 mm posterior and 10 mm proximal to the lateral epicondyle. A guide wire is inserted into the femur, starting from the outer side and moving towards the inner side, with the goal of aiming towards the front and upper part to prevent any contact with the trochlea or the ACL tunnel. Then, a drill pit with a hollow center is used to build a 7mm tunnel in the femur, following the same path from the outer to the inner side.

2.2.2.2 Rehabilitation program

2.2.2.2.1 Pre-Op Phase

The onset of this condition occurs quickly after the occurrence of an injury, and its resolution is typically observed after undergoing a surgical procedure.Comma.

2.2.2.2.2 Immediate Post Operative Phase

Commences on the day of the surgical procedure and persists until the patient initiates physical therapy. This time period encompasses the first week after the operation, specifically from the 1st to the 7th day postoperative, or the initial week of clinical care extending into the second week.

2.2.2.2.3 Early Functional Rehabilitative Phase

(During the period of 2 to 4 weeks following a surgical procedure, or specifically from the second through the fourth week of receiving medical treatment).

2.2.2.2.4 Mid Functional Rehab Phase

(Between 5 and 8 weeks after surgery, or throughout the period of clinical care spanning from the fifth to the eighth week).

2.2.2.2.5 Late Functional Rehab Phase

(9-16 weeks after the operation, or during the period from the ninth to the sixteenth week of clinical care) Furthermore **Functional Progression To Sport** (4-9 months after the operation, or during the fourth through ninth month of medical treatment). **Follow-up evaluation: ROM** (Active, Passive ROM), **Pivot Shift test** and **Scoring (**Lysholm, Subjective IKDC score at final follow-up).

2.3 Statistical Analysis

The normality of the data distribution was checked using the Shapiro-Wilk test. We used IBM Corp's SPSS Version 22.0 (Armonk, NY) to characterize quantitative factors. We utilized percentages and frequencies for qualitative variables. By utilizing a Chi-square test, an

independent sample t-test, and a P value less than.05, the treatment groups were compared.

3. Discussion

There was no statistically significant difference between the groups when looking at age, sex, sports activity, ASA physical status, injury mechanism, side, dominance, time since injury, or duration of follow-up. At 6, 12, and 24 months post-operatively, there was a statistically significant improvement in anteroposterior stability compared to preoperative results in both groups (Figures 1-4). However, there was no significant difference between the groups studied regarding the Lachman test either before or after surgery (P > 0.05). It should be mentioned that Goncharov et al. showed that the Lachman score was used to evaluate anteroposterior stability, and that both ACLR with and without ACLR showed significant gains. There was no discernible difference between the ACLR only and ACLR plus ALLR algorithms with respect to the Lachman score. Using the Pivot Shift score, the current investigation found that both groups significantly improved their rotational stability at6,12, and 24 months postoperatively compared to preoperative data [7]. According to the study, there was no significant difference in the findings of the pivot shift test that was conducted before surgery among the groups. The combination of ACLR and ALLR resulted in significantly superior pivot shift performance at6,12, and 24 months postoperatively compared to ACLR and LET alone (Chi-square test, P = 0.000). Research by Na et al. indicated that, when comparing ALLR with ACLR to LET with ACLR, the former seemed to provide higher rotational stability improvements [8]. This finding is in line with the present study. Regarding postoperative rotational stability as measured by the Pivot Shift score, there was no significant difference between ACLR+ALLR and ACLR+LET, according to a network meta-analysis of 1,077 patients from 11 RCTs conducted by Park et al.[9]. This finding contradicts the current study. The present research shown that both groups' knee range of motion improved significantly from preoperative to6,12, and 24 months postoperatively (Repeated measures ANOVA, P = 0.000). However, when comparing the groups' range of motion before and after surgery, there was no statistically significant difference (Independent sample t test, P > 0.05). Potential side effects of the extra-articular tenodesis technique include decreased range of motion and lateral knee pain due to over-constraint of the knee [10,11]. Sonnery-Cottet et al. found that ROM was significantly improved with either ACLR plus ALLR or ACLR alone, but that ACLR plus ALLR had superior ROM outcomes than ACLR alone [12]. This finding is consistent with the current study.

Statistical analysis revealed a statistically significant improvement in Lysholm ratings from pre- to 6, 12, and 24 months post-operatively in both groups (Repeated measures ANOVA, P = 0.000). There was no statistically significant difference between the groups at 3, 6, and 2months post-op with respect to range of motion (ROM) before and after surgery (Independent sample t test, P > 0.05). On the other hand, the ALLR plus ACLR group had a significantly higher Lysholm score at the 24-month mark (Independent sample t test, P = 0.025). Helito et al. showed that the ALLR plus ACLR method produced a much higher Lysholm score [13] compared to the LET plus ACLR methodology, which is in line with the current analysis. Between the pre- and post-operative periods (6, 12, and 24 months), the IKDC scores of both groups showed a substantial improvement, according to the results of the repeated measures ANOVA (P = 0.000). When comparing the groups' range of motion before and after surgery at the 3-and 6-month follow-ups, an independent sample t test revealed no statistically significant difference (P > 0.05). However, the ALLR plus ACLR group demonstrated significantly higher IKDC scores at 12 months and 24 months, respectively (Independent sample t test, P = 0.015 and 0.002, respectively). Comparing standalone ACLR to ACLR with a LET or ALLR, Boksh et al. shown that the latter two can improve subjective IKDC ratings [14]. Residual instability was shown to be more common in the group who received LET in conjunction with ACLR, according to the present study (Chi-square test, P = 0.001). While comparing the occurrence of infection, hemarthrosis, re-rupture, and reoperation between the groups, no statistically significant difference was found (Chi-square test, P > 0.05). Consistent with the present investigation, Na et al. demonstrated that, in comparison to ALLR with ACLR, patients undergoing LET in conjunction with ACLR were more likely to experience knee stiffness and adverse effects [8]. The present study has some limitations, such as a small sample size, a single center design, and a very short time of follow-up. To validate our findings and identify potential risk factors for unfavorable outcomes, more comparison research are required with bigger samples and longer follow-up periods.

Figure 1: Passage of all graft through tibial tunnel

Figure 2: Tightness of all graft to the ACL grafts suture, excision of the excess suture and graft and illiotibial band closure

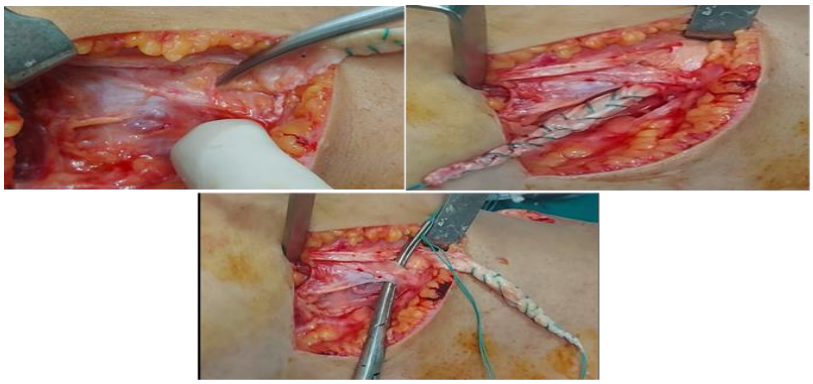

Figure 3: Identification of lateral collateral ligament and passing ITB graft under it

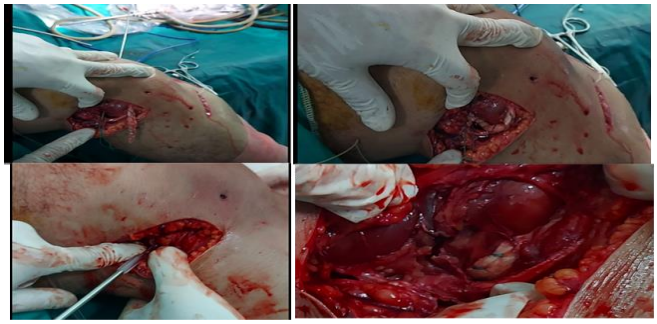

Figure 4: Passage and fixation of ITB graft to the frmoral tunnel

Table 1. Baseline Demographic Data (N = 60)		
Variables	**No.**	**%**
Age, years	28.7 ± 6.8 (Range, 18 – 40)	
Less than 25	19	31.7
25 – 35	26	43.3
More than 35	15	25
Gender		
Male	55	91.7
Female	5	8.3
Sports Activity		
Recreational	42	70
Professional	18	30
ASA Physical State		
Grade I	41	68.3
Grade II	19	31.7
Mechanism of Injury		
Noncontact Trauma	38	63.3
Contact Trauma	22	36.7
Side of Injury		
Right	42	70
Left	18	30
Dominance of Injured Side		
No	15	25
Yes	45	75
Time Since Injury, months	6 ± 2.6 (Range, 2 – 10)	
Follow-up, months	42 ± 3.7 (Range, 36 – 48)	

There was no statistically significant difference between the studied groups as regard age, sex, Sports Activity, ASA Physical State, Mechanism of Injury, side, Dominance, Time Since Injury and follow-up duration.

Table 2. Stability Tests (N = 60)								
Variables	**Grade 0**		**Grade I**		**Grade II**		**Grade III**	
Lachman Test								
Baseline			5	8.3	42	70	13	21.7
3-month follow-up	47	78.3	9	15	4	6.7	0	0
6-month follow-up	50	83.3	10	16.7	0	0	0	0
12-month follow-up	55	91.7	5	8.3	0	0	0	0
24-month follow-up	57	95	3	5	0	0	0	0
36-month follow-up	57	95	3	5	0	0	0	0
P* value	0.001							
Pivot Shift Test								
Baseline	0	0	0	0	33	55	27	45
3-month follow-up	31	51.7	21	35	6	10	2	3.3
6-month follow-up	46	76.7	10	16.7	3	5	1	1.7
12-month follow-up	51	85	6	10	3	5	0	0
24-month follow-up	53	88.3	5	8.3	2	3.3	0	0
36-month follow-up	53	88.3	5	8.3	2	3.3	0	0
P* value	0.001							
*** Repeated measures ANOVA test.**								

There was no statistically significant difference was found between groups regarding Lachman and pivot shift test preoperatively, or postoperatively at 3-, 6-, 12-, 24-, and 36-month follow-up (Chi-square test, $P > 0.05$).

Table 3. Range of Motion (N = 60)					
	Group A (N = 30)		Group B (N = 30)		*P* value*
	Mean	SD	Mean	SD	
ROM, degrees					
Baseline	132.6	4.8	132.3	4.7	0.808
3 months	135.1	3.9	135.3	4.2	0.901
6 months	136	3.7	136.3	4.2	0.774
12 months	136.5	3.7	137.1	4.2	0.521
24 months	136.9	3.7	137.4	4.1	0.577
36 months	136.9	3.7	137.4	4.1	0.577
P* value*	0.000		0.000		
*** Independent Sample t test. ** Repeated measures ANOVA**					

There was no statistically significant difference was found between groups regarding preoperative and postoperative ROM (Independent sample t test, P > 0.05).

Table 4. Lysholm Score (N = 60)					
	Group A (N = 30)		Group B (N = 30)		*P* value
	Mean	SD	Mean	SD	
Lysholm Score					
Baseline	58.1	3.7	58.7	4.5	0.559*
3 months	84.3	6.4	85.3	8.7	0.628*
6 months	86.4	4.4	86.2	7.6	0.902*
12 months	88.7	3.2	87.2	7.1	0.291*
24 months	90.9	6.1	87.4	8.7	0.073*
36 months	90.9	6.1	87.4	8.7	0.073*
P* value*	0.000		0.000		
Knee Function at 36 months					0.451***
Excellent	14 (46.7%)		11 (36.7%)		
Good	11 (36.7%)		13 (43.3%)		
Fair	5 (16.7%)		4 (13.3%)		
Poor	0 (0)		2 (6.7%)		
*** Independent Sample t test. ** Repeated measures ANOVA *** Chi-square test**					

There was no statistically significant difference was found between groups regarding preoperative and postoperative Lysholm score at different follow-up intervals (Independent sample t test, P > 0.05).

Table 5. IKDC Score (N = 60)

	Group A (N = 30)		Group B (N = 30)		*P* value
	Mean	SD	Mean	SD	
IKDC Score					
Baseline	50.7	4.2	52.4	5.1	0.164
3 months	80.6	5.9	77.7	6.1	0.061
6 months	82.4	4.6	81.3	5.8	0.421
12 months	84.2	3.6	82.3	6.1	0.161
24 months	88.3	4.3	85.5	8.2	0.096
36 months	88.3	4.3	85.5	8.2	0.096
P* value*	0.000		0.000		
Knee Function at 36 months					0.106***
Excellent	11 (36.7)		10 (33.3)		
Good	17 (65.7)		11 (36.7)		
Fair	2 (6.7)		7 (23.3)		
Poor	0 (0)		2 (6.7)		

*** Independent Sample t test.**

**** Repeated measures ANOVA**

***** Chi-square test**

There was no statistically significant difference was found between groups regarding preoperative and postoperative IKDC score at different follow-up intervals (Independent sample t test, P > 0.05).

Table 6. Complications (N = 60)

	Group A (N = 30)		Group B (N = 30)		*P* value*
	No.	%	No.	%	
SSI	1	3.3	1	3.3	1.000
Stiffness	1	3.3	1	3.3	1.000
DVT	1	0	0	0	0.313
Residual Instability	1	3.3	1	3.3	1.000
Re-rupture	1	0	0	0	0.313
Re-operation	1	0	0	0	0.313
Lateral Joint Pain	1	3.3	4	13.3	0.082

*** Chi-square test.**

There was no statistically significant difference was observed between groups regarding the incidence of infection, stiffness, DVT, residual instability, re-rupture, reoperation, or lateral join pain (Chi-square test, $P > 0.05$).

4. Conclusion

The current study concluded that high-demand knees can be safely and effectively treated with anterior cruciate ligament (ACL) reconstruction in conjunction with either lateral extraarticular tenodesis (LET) or anterolateral ligament reconstruction (ALLR). Long-term follow-ups showed improved rotational stability and functional results with ACLR combined with ALLR, and the treatment was linked with a decreased incidence of complications compared to LET.

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