COMPARISON OF FUNCTIONAL OUTCOMES BETWEEN ADJUSTABLE- AND FIXED-LOOP DEVICES FOR FEMORAL FIXATION IN ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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Abstract

Objectives: To compare outcomes of anterior cruciate ligament reconstruction (ACLR) with adjustable- and fixed-loop devices. ***Methods:*** A retrospective, observational study was conducted on 92 patients who underwent ACLR with the fixation of a hamstring graft with the fixed- and adjustable-loop suspensory devices on the femoral side from December 2021 to December 2023. Knee function was evaluated using the Lysholm score, Lachman test, and Pivot-shift test, both preoperatively and at the one-year postoperative follow-up. ***Results:*** One year postoperatively, the Lysholm score averaged 90.62 ± 4.167 in the adjustable-loop group, with 83.1% of cases achieving good grades. In comparison, the fixed-loop group had a mean score of 90.15 ± 4.704, with 77.8% of cases obtaining good grades. However, no significant statistical difference was found between the two groups ($p > 0.05$). A negative pivot shift test was confirmed in 60 cases (92.3%) from the adjustable-loop group and 24 cases (88.9%) from the fixed-loop group ($p = 0.5$). No cases of infection, graft failure, or flexion limitation were recorded. ***Conclusion:*** There were no notable differences in graft laxity and functional outcomes between the fixed- and adjustable-loop devices for femoral fixation in arthroscopic ACLR.

Keywords: Anterior cruciate ligament; Adjustable-loop; Fixed-loop; Suspensory fixation.

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INTRODUCTION

Injuries to the anterior cruciate ligament (ACL) are common, with an annual incidence of approximately 5 per 10,000 individuals, especially among high-impact athletes [1]. Arthroscopic ACLR is considered a standard treatment, with the objective of restoring knee stability and mechanics. Well-defined tunnel placement and reliable graft fixation are important for optimal outcomes. Suspensory fixation techniques, including fixed-loop and adjustable-loop systems, allow the use of longer grafts for femoral tunnels. Fixed-loop devices diminish slippage and ensure graft strength via external cortical bone support and ribbon fixation. However, their capabilities may be limited in short graft tunnels or by improper graft positioning. Adjustable-loop systems, with a finger-trap mechanism, are preferable in short tunnels, supporting more graft material in the tunnel without over-drilling. These systems allow intraoperative tightening to optimize graft placement and minimize complications such as femoral attic formation or the "bungee cord effect" [2]. While fixed-loop devices secure fixation and maintain graft strength, the impact of loop type and tunnel length on clinical outcomes remains unclear. A limited number of studies have compared fixed-loop and adjustable-loop systems in ACLR with hamstring grafts [3, 4]. This study aims to: *Compare two suspensory systems for femoral tunnel on graft laxity and functional outcomes, including Lysholm knee scores, in arthroscopic ACLR.*

MATERIALS AND METHODS

1. Subjects

Including 92 cases suffering from ACL injuries who underwent arthroscopic ACLR at the Department of Joint Surgery, Military Hospital 103 from December 2021 to December 2023.

* *Inclusion criteria:* Aged ≥ 18 years; primary ACL surgery; unilateral ACL tear without additional ligament injuries; no prior knee surgeries; and clinically and MRI-confirmed ACL rupture.

* *Exclusion criteria:* Multiple ligament injuries or significant cartilage damage; alternative femoral fixation techniques; severe osteoarthritis (Kellgren-Lawrence grade 3 - 4) or advanced osteoporosis; and bilateral ACL injuries.

Patient demographics, diagnostic findings, surgical data, and follow-up details were collected from the hospital database, with additional data obtained through phone-based follow-up scheduling during 1 year. All cases in both groups were managed with a similar surgical technique and postoperative protocol.

2. Methods

* *Study design:* A retrospective, observational study.

* *Surgical procedure:* Following arthroscopic confirmation of an ACL tear, a tripled hamstring tendon graft was harvested and pre-tensioned. The femoral tunnel, drilled through the anteromedial portal with the knee in hyper-flexion, was sized to match the graft. The graft was arthroscopically passed through the tunnels with fixed- or adjustable-loop devices. Arthroscopic reassessment confirmed graft tension, with re-tensioning carried out to ensure firm positioning in the femoral socket using alternating traction on the white strands. Knee range of motion was evaluated to verify graft stability and rule out notch impingement. All procedures were performed by senior surgeons, with perioperative antibiotics administered according to institutional guidelines.

* *Rehabilitation procedure:* From the second postoperative day, patients were instructed to bear weight as tolerated using crutches and a knee brace locked in extension. During the first two weeks, rehabilitation focused on patellar mobilization, reaching flexion up to 90° and full passive extension. By 6 weeks, progression to full knee flexion was encouraged, while active terminal extension was restricted until this point. Patients were gradually weaned off the brace and crutches upon demonstrating adequate quadriceps control. The knee brace was recommended for the first 4 weeks and discontinued based on patient comfort. Return to sports was considered after 6 - 8 months.

* *Study variable:* Outcomes were assessed through the Lysholm score, Lachman test, and pivot shift test [2]. The Lysholm score classified results as excellent (from 95 - 100), good (from 84 - 94), fair (from 65 - 83), or poor (< 65). Both groups show comparable demographics and similar preoperative and intraoperative variables. Follow-up evaluations occurred at one year post-surgery.

* *Statistical analysis:* Data analysis was conducted utilizing SPSS software (version 20.0, IBM Corp., USA). Categorical variables were assessed via the Chi-square test, while continuous variables were analyzed with the paired T-test. Statistical significance was determined at a p-value threshold of less than 0.05.

3. Ethics

The research was approved by the Institutional Ethics Committee (No. 192/HĐĐĐ, June 15th 2022). The Department of Joint Surgery, Military Hospital 103 granted permission for the use and publication of the research data. The authors declare to have no conflicts of interest in the study.

RESULTS

This study included 92 cases, comprising 79 males (85.9%) and 13 females (14.1%), with an average age of 32.15 ± 10.38 years (range: 19 - 60). Sports-related accidents accounted for 60 cases (65.2%) of ACL injuries, followed by traffic accidents (28 cases, 28.3%) and routine activities (7 cases). The mean interval between injury and surgery was 13.26 ± 14.75 weeks (range: 1 - 72), and meniscal injuries were present in 28 cases (30.4%). The mean hospital stay was 14.27 ± 4.91 days (range: 6 - 31). No significant differences were detected between the groups in demographic characteristics or injury profiles, including age, gender, injury mechanism, affected side, meniscal injury rate, or timing of surgery and hospitalization (*Table 1*).

Table 1. Demographic data and group characteristics (n = 92).

Parameter		Adjustable-loop	Fixed-loop	p
Mean age		31.46 ± 9.757	33.81 ± 11.793	0.325
Gender	Male	57 (87.7%)	22 (81.5%)	0.436
	Female	8 (12.3%)	5 (18.5%)	
Injury causes	Sports injuries	45 (69.2%)	15 (55.6%)	0.442
	Routine activity injuries	16 (24.6%)	10 (37.0%)	
	Traffic accidents	4 (6.2%)	2 (7.4%)	
Time from injury to surgery (weeks)		11.91 ± 12.237	16.52 ± 3.740	0.174
Meniscus tear	Yes	43 (66.2%)	21 (77.8%)	0.270
	No	22 (33.8%)	6 (22.2%)	
Side involved	Right	34 (52.3%)	19 (70.4%)	0.110
	Left	31 (47.7%)	8 (29.6%)	
Length of hospital stay (days)		14.31 ± 4.776	14.19 ± 5.321	0.914

Preoperative Lysholm scores revealed poor knee function in 95.7% of cases, with a mean score of 54.48 ± 5.49 (range: 42 - 66). One year postoperatively, substantial improvements were noted, with 81.5% of cases achieving good outcomes and 18.5% fair outcomes based on the Lysholm score. Preoperative evaluations, including the Lachman test, pivot-shift test, and Lysholm score, displayed no significant differences between the two groups (p > 0.05).

Table 2. Preoperative clinical assessment.

Parameter		Adjustable-loop	Fixed-loop	p
Lachman test	Grade 1	4 (6.2%)	1 (3.7%)	0.570
	Grade 2	13 (20%)	8 (29.6%)	
	Grade 3	48 (73.8%)	18 (66.7%)	
Pivot-shift test	Grade 1	6 (9.2%)	3 (11.1%)	0.367
	Grade 2	32 (49.2%)	17 (63.0%)	
	Grade 3	27 (41.5%)	7 (25.9%)	
Lysholm score		54.25 ± 5.640	55.04 ± 5.185	0.533
Poor		61 (93.8%)	27 (100%)	0.188
Fair		4 (6.2%)	0	

One-year postoperative evaluations indicated notable improvements in both groups. The mean Lysholm score increased by 36.00 ± 3.419 (range: 28 - 42). Most cases achieved grade 0 in the Lachman and pivot-shift tests, with no significant intergroup differences ($p > 0.05$). Although both groups showed significant postoperative Lysholm score improvements, the extent of improvement was not statistically different ($p = 0.108$) (*Table 3*). No complications, such as infections, graft failures, or flexion restrictions, were observed in either group.

Table 3. Postoperative clinical assessment at 1 year.

Parameter		Adjustable-loop	Fixed-loop	p
Lachman test	Grade 0	54 (83.1%)	21 (77.8%)	0.551
	Grade 1	11 (16.9%)	6 (22.2%)	
Pivot-shift test	Grade 0	60 (92.3%)	24 (88.9%)	0.596
	Grade 1	5 (7.7%)	3 (11.1%)	
Lysholm score		90.62 ± 4.167	90.15 ± 4.704	0.467
Fair		11 (16.9%)	6 (22.2%)	0.551
Good		54 (83.1%)	21 (77.8%)	
Change in Lysholm score		36.37 ± 3.773	35.11 ± 2.172	0.108

DISCUSSION

Our study evaluated the functional results of arthroscopic ACLR with fixed-loop and adjustable-loop systems through graft laxity and Lysholm knee scores. The average ages in the fixed- and adjustable-loop groups were 34.5 ± 11 and 34.1 ± 9.1 years, respectively, comparable to the findings of Chandru et al. [3], who reported mean ages of 33.81 ± 11.7 and 31.46 ± 9.7 years. Meniscal injuries were recorded in 77.8% of fixed-loop cases and 66.2% of adjustable-loop cases in this study, consistent with Schützenberger et al., who reported a 64% prevalence of meniscal tears in ACL injuries [4]. Adjustable-loop devices, as advanced femoral cortical suspension systems, offer distinct advantages, including eliminating the need to pre-calculate loop length or over-drill the femoral tunnel. They also permit maximal graft insertion in short femoral tunnels, reducing the need for multiple fixed-loop sizes in inventory. In this study, most cases required reconstruction due to grade 2 or 3 instability, as assessed by the Pivot-shift and Lachman tests preoperatively. Postoperatively, knee stability was regained in most cases, with 81.5% testing negative for the Lachman test and 91.3% negative for the Pivot-shift test. Chandru et al. [3] reported that 92.3% of cases in both the fixed- and adjustable-loop groups showed negative graft laxity tests after one year. Asif et al. [6] demonstrated that 87% of cases with a variable-loop device were negative for the Lachman test, and 95.7% were negative for the Pivot-shift test. Shahpari et al. [7] reported negative Lachman and Pivot-shift tests in 81.8% and 87% of fixed-loop cases, respectively. Regarding functional outcomes, Lysholm knee scores in our study were 90.15 and 90.62 in the fixed- and adjustable-loop groups, respectively, at one year, comparable to Chandru et al. [3] (91.54 and 91.69) and Asif et al. [6] (91.4 and 91.0). While no significant difference in scores was observed at one year, our study noted a statistically significant difference at six weeks postoperatively. To the best of our knowledge, this is the only study to periodically compare Lysholm knee scores between fixed- and adjustable-loop groups over one year post-surgery, permitting for an assessment of functional improvement over time. The Lysholm score, a generally used knee-specific scoring system, has revealed acceptable test-retest reliability and internal consistency in a study by Briggs et al. including over 1000 ACLR cases [8]. Its concise and informative nature justified its use as the sole measure for patient-reported outcomes in this study. Graft laxity was assessed clinically using Lachman and anterior drawer tests by comparing the affected and normal knees, as arthrometer use was not feasible. Despite a longer one-year follow-up period, the study reported no statistically significant difference in graft laxity between the two groups. Some in vitro studies suggest that adjustable-loop devices may be inferior to fixed-loop devices due to elongation under cyclical loads, potentially compromising graft function during the critical 8 - 12 weeks of early recovery. However, other studies report no notable discrepancies between the two devices in terms of functional outcomes [9]. In our study, Lysholm scores and knee laxity assessments (Lachman and pivot shift tests) at the last follow-up were consistent with prior findings on fixed-loop cortical-suspension devices. The gap between biomechanical and clinical studies may arise from limitations in laboratory simulations, which fail to mimic the complex in vivo biomechanical and physiological environment. Graft healing plays a crucial role in the success of ACLR and is influenced by factors including graft type, tunnel length and orientation, graft length within the tunnel, tunnel-graft diameter mismatch, graft tension, motion within the tunnel, and fixation type. Our study focused only on comparing two fixation methods, not mentioning other contributing factors. Although biomechanical studies often suggest increased graft slippage in variable-loop designs compared to fixed-loop designs, clinical studies, including ours, have not illustrated this difference, indicating that biomechanical findings may not fully represent clinical outcomes.

Our study had several limitations. Knee stability was assessed subjectively through the Lysholm score, Lachman test, and pivot shift test rather than instrument-assisted methods like an arthrometer. Nevertheless, all evaluations were performed by a senior professor with over 30 years of clinical experience who was blinded to the surgical method, reducing subjective bias.

CONCLUSION

Our study showed no statistically significant difference in laxity of the graft or functional outcomes of arthroscopic ACLR with fixed- and variable-loop devices at one year of follow-up. These findings offer important evidence to assist surgeons in choosing between the two devices, considering factors like surgical technique preference, cost, or patient-specific needs, without worrying about variations in clinical outcomes.

REFERENCES

1. van Meer BL, et al. Which determinants predict tibiofemoral and patellofemoral osteoarthritis after anterior cruciate ligament injury? A systematic review. *Br J Sports Med.* 2015 Aug; 49(15):975-983.

2. Choi NH, et al. Clinical and radiological outcomes after hamstring anterior cruciate ligament reconstructions: Comparison between fixed-loop and adjustable-loop cortical suspension devices. *Am J Sports Med*. 2017 Mar; 45(4):826-831.

3. Chandru V, et al. Comparison of fixed- and variable-loop button fixation in arthroscopic anterior cruciate ligament reconstruction. *Cureus*. 2022 Apr 17; 14(4):e24218.

4. Schützenberger S, et al. ACL reconstruction with femoral and tibial adjustable versus fixed-loop suspensory fixation: a retrospective cohort study. *J Orthop Surg Res.* 2022 Apr 19; 17(1):244.

5. Seo SS, et al. Clinical results comparing transtibial technique and outside in technique in single bundle anterior cruciate ligament reconstruction. *Knee Surg Relat Res*. 2013 Sep; 25(3):133-140.

6. Asif N, et al. A prospective randomized study of arthroscopic ACL reconstruction with adjustable- versus fixed-loop device for femoral side fixation. *Knee Surg Relat Res.* 2021 Dec 4; 33(1):42.

7. Shahpari O, et al. Clinical outcome of anatomical transportal arthroscopic anterior cruciate ligament reconstruction with hamstring tendon autograft. *Arch. Bone Jt. Surg*. 2018; 6:130.

8. Briggs KK, et al. The reliability, validity, and responsiveness of the Lysholm score and Tegner activity scale for anterior cruciate ligament injuries of the knee: 25 years later. *Am J Sports Med*. 2009; 37:890-897.

9. Ranjan R, et al. In vivo comparison of a fixed loop (EndoButton CL) with an adjustable loop (TightRope RT) device for femoral fixation of the graft in ACL reconstruction: A prospective randomized study and a literature review. *J. Orthop. Surg.* 2018; 26:2309499018799787.