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Role of Meniscal Ramp Lesion Repair in Preventing Residual Instability after Anterior Cruciate Ligament Reconstruction

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Learning Point of the Article:

Meniscal ramp lesions are frequently associated with chronic ACL injuries and can contribute to persistent post-operative knee instability if left untreated. Routine arthroscopic evaluation of the posteromedial compartment during ACL reconstruction is essential for optimal surgical outcomes.

Abstract

Introduction: Anterior cruciate ligament reconstruction (ACLR) is a common procedure done to regain knee stability, but even after the technical success of the operation; some patients still experience residual instability. Anterior cruciate ligament (ACL) injuries are regularly accompanied by meniscal ramp lesions, which concern the posteromedial meniscocapsular junction and can lead to a persistent anterior and rotational laxity in case of inadequate treatment. Whether ramp lesion repair could help in avoiding residual instability after ACLR is a controversial issue.

Materials and Methods: The proposed study is a prospective observational comparative study involving 50 participants who planned to undergo arthroscopic ACLR as a primary operation in a tertiary care unit. The findings during intraoperative were used to categorize the patients into two groups: Group A (ACLR and concomitant ramp lesion repair; n = 25) and Group B (isolated ACLR and no ramp lesion; n = 25). Lachman test and pivot-shift test were used to measure post-operative knee stability, and Lysholm Knee Scoring Scale and subjective International Knee Documentation Committee (IKDC) score at six months follow-up were used to measure functional outcomes.

Results: Group A exhibited a high rate of post-operative knee stability, with 88% having a negative Lachman test in comparison to Group B (72%), with residual pivot-shift positivity being significantly low in Group A (16%) compared to Group B (40%) (P = 0.03). The ramp repair group also performed better in terms of functional outcomes, having a higher mean Lysholm score (93.6 ± 4.8 vs. 88.9 ± 6.2) and a high percentage of normal IKDC score (56 vs. 32). The parameters of residual instability were much lower in patients who received ramp lesion repair.

Conclusion: Meniscal ramp lesion repair done together with ACLR enhanced substantially residual knee instability and short-term functional outcomes. This can be improved by systematic assessment and proper management of ramp lesions during ACLR to increase the stability of the knee post-surgery and maximize patient outcomes.

Keywords: Anterior cruciate ligament reconstruction, functional outcome, knee instability, meniscal ramp lesion, pivot-shift test.

Introduction

One of the most common orthopedic procedures is anterior cruciate ligament reconstruction (ACLR) aimed at restoring the knee stability and functionality following the ligamentous

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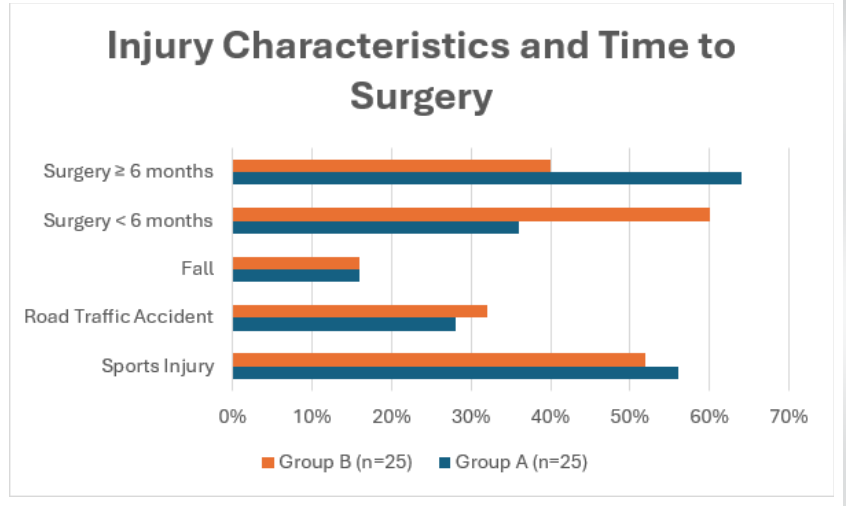

Figure 1: Injury characteristics and duration from injury to surgery among study groups.

trauma; however, a subgroup of patients continues to complain of certain rotational instability despite anatomically successful reconstruction, which is worrying [1] as it suggests that certain comorbid injuries are not detected and not managed. Among them, the meniscal ramp lesions, as longitudinal tears of the peripheral attachment of the anterior horn of the medial meniscus to the meniscocapsular or meniscotibial junction, have been of increasing importance as the causes of the post-operative instability and the high incidence of them in anterior cruciate ligament (ACL)-deficient knees [2]. The medial meniscus is the secondary knee stabilizer; it is extremely vital, particularly in the anterior tibial translation and rotational forces. ACL is destroyed, and damage to its posterior horn has serious implications on the biomechanics of the knee [3]. The ramp lesions that are underdiagnosed and undertreated are the lesions that are not routinely observed during normal arthroscopic examination because they are in the rear position, and minimum lesions are observed using the regular anterior portals [4]. "Some biomechanical studies have demonstrated that ramp lesions, which have not been treated, result in more anterior laxity and internal tibial rotation despite ACLR and contributes to poor graft performance and contributes to chronic instability [5]. It has been reported that there is a high relationship between ramp lesions and chronic ACL injuries of a prevalence rate between 9% and 40%, which means ramp lesions are more likely to be experienced in case of delayed reconstruction due to repeated occurrences of instability [6]. Besides, the magnetic resonance imaging (MRI) is advantageous, although it is less sensitive to identify ramp lesions, and this is where systematic arthroscopic examination of the posteromedial compartment is thought to be significant in ACLR [7]. Further discussion is in the treatment of ramp lesions, in which the stable lesions are spontaneously cured since the peripheral meniscus is vascular, unstable, or complete tear has been found to be treated with successful surgery repair [8]. It has been reported that all-inside and inside-out arthroscopic repair techniques have shown good healing outcomes and biomechanical stability on the combination of these methods with ACLR [9]. The available clinical outcome research results indicate that patients undergoing combined ACLR and repair of ramp lesions experience higher post-operative knee stability, reduced grade of pivot-shift, and improved functional scores compared to their counterparts receiving no ramp lesion repair [10]. Further, the lack of treatment of ramp lesions has also been cited as a potential risk factor that contributed to the failure of the graft, particularly in young and active individuals who require more functions of the reconstructed knee [11]. Although more and more evidence has been produced on the topic of repairing ramp lesions, there is still uncertainty in the practice of surgery, and there are no agreed-upon guidelines on indications, timing, and means of repair [12]. This is why it is necessary to carry out further research to offer some clarifications in the relevance of meniscal ramp lesion repair in the prevention of residual instability following ACLR. The importance of ramp lesions to the

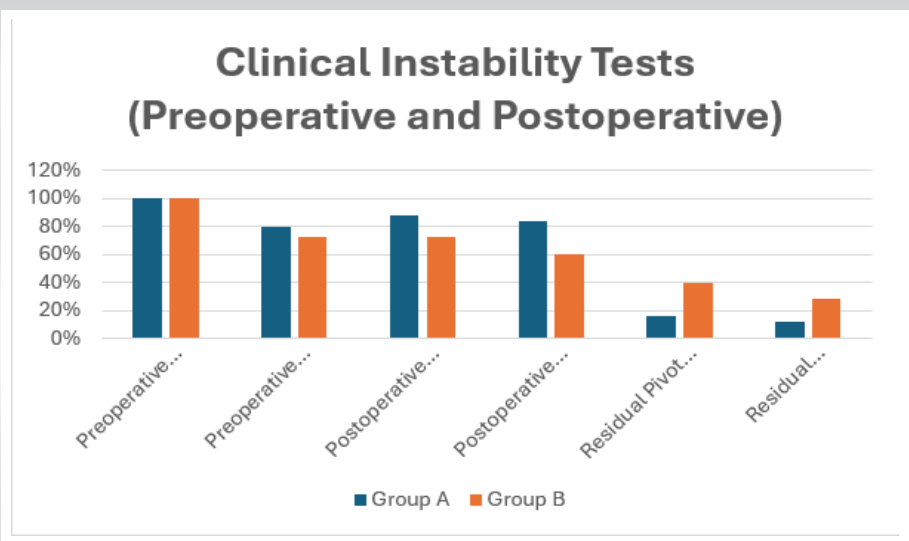

Figure 2: Comparison of pre-operative and post-operative instability tests between study groups.

Table 1: Demographic characteristics of study participants			
Variable	Group A (ACLR+Ramp repair) *n*=25 (%)	Group B (Isolated ACLR) *n*=25 (%)	Total
Mean age (years)	31.8±6.4	32.2±6.1	32.0±6.2
Male	20 (80)	19 (76)	39 (78)
Female	5 (20)	6 (24)	11 (22)
Most common age group	26–35 years (48)	26–35 years (52)	50
ACLR: Anterior cruciate ligament reconstruction			

biomechanics and functional outcomes of the post-operative knee is an important aspect that should be taken into consideration in an attempt to streamline the surgical process to maximize patient satisfaction and reduce the chances of revisionary surgery. Despite increasing evidence regarding ramp lesion repair, uncertainty remains regarding its routine management during ACLR. Therefore, the present study was conducted to evaluate the role of meniscal ramp lesion repair in preventing residual instability and improving post-operative functional outcomes following ACLR [13].

Materials and Methods

Study design

This multicentric prospective observational comparative study was conducted in the Departments of Orthopedics of various tertiary care teaching hospitals equipped with advanced arthroscopic surgical facilities and post-operative rehabilitation services over a period of 18 months, including patient recruitment, surgical intervention, and follow-up evaluation. The study was designed to evaluate the role of meniscal ramp lesion repair in preventing residual instability after ACLR. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all patients before inclusion in the study.

Participants

Inclusion criteria

- Patients with an age between 18 and 45 years
- Patients with a unilateral and confirmed ACL tear through clinical examination, accompanied by MRI
- Patients who underwent primary arthroscopic ACLR
- Patients who can give informed written consent and agree to follow-up protocol.

Exclusion criteria

- Multiligamentous knee injuries
- Previous surgery on the affected knee
- Advanced osteoarthritis of the knee (Kellgren-Lawrence grade ≥2)
- Associated fractures around the knee joint
- Infectious or inflammatory knee pathology.

Study sampling

Study participants were selected using a consecutive sampling method. The eligible patients who presented to the orthopedic outpatient department or emergency services during the study period and met the inclusion criteria were consecutively enrolled until a predefined sample size was achieved. This sampling strategy was selected to decrease selection bias and approximate the population under study to real-world clinical practice.

Study sample size

The sample size of 50 patients was determined based on previous comparable studies, expected case availability, and study feasibility during the study period. The study was designed as an exploratory comparative observational study to evaluate post-operative stability and functional outcomes following ACLR with and without ramp lesion repair.

Study groups

Participants were divided into two groups based on intraoperative arthroscopic findings. Group A included patients with ACL tears associated with meniscal ramp lesions who underwent simultaneous ramp lesion repair during ACLR. Group B included patients with isolated ACL tears without ramp lesions who underwent isolated ACLR. Group allocation was based on arthroscopic findings and was not randomized.

Table 2: Injury characteristics and time to surgery		
Variable	Group A (*n*=25) (%)	Group B (*n*=25) (%)
Sports injury	14 (56)	13 (52)
Road traffic accident	7 (28)	8 (32)
Fall	4 (16)	4 (16)
Surgery <6 months	9 (36)	15 (60)
Surgery ≥6 months	16 (64)	10 (40)

Table 3: Clinical instability tests (pre-operative and post-operative)		
Parameter	**Group A (%)**	**Group B (%)**
Pre-operative Lachman positive	25 (100)	25 (100)
Pre-operative pivot shift positive	20 (80)	18 (72)
Post-operative negative Lachman (6 months)	22 (88)	18 (72)
Post-operative negative pivot shift (6 months)	21 (84)	15 (60)
Residual pivot shift	16	40
Residual Lachman positivity (%)	12	28

Study parameters

The main outcome measures were a clinical test-based assessment of residual knee instability (Lachman test, anterior drawer test, and pivot shift test). Secondary outcome measures were functional outcome measured by validated knee scoring systems (Lysholm Knee Scoring Scale and International Knee Documentation Committee [IKDC] subjective score). Other factors considered included patient demographics, mechanism of injury, interval to surgery, and intraoperative findings.

Study procedure

Patients underwent arthroscopic ACLR and were placed under general or spinal anesthesia following a standardized protocol for surgery. Initially, diagnostic arthroscopy was done to confirm an ACL tear as well as to determine any intra-articular pathology. The posteromedial compartment was systematically evaluated to identify ramp lesions. Patients with a ramp lesion also underwent arthroscopic repair of the lesions using an all-inside technique to repair the lesion with suture devices. The ACL was then reconstructed using hamstring tendon autograft with accurate tunnels and fixation. All patients underwent an early range of motion, progressive strengthening, and gradual return to activity according to a standardized rehabilitation protocol postoperatively.

Study data collection

Data were collected using a structured pro forma designed specifically for the study. Pre-operative data comprised patient demographics, injury features, and baseline clinical findings. Details of intraoperative findings, including the presence/absence of ramp lesions and surgical procedures performed, were noted. Clinical evaluations and functional scores were recorded during routine post-operative follow-up. All clinical data were recorded by the treating orthopedic team using a structured pro forma.

Data analysis

The data collected were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences software. We summarized demographic and clinical variables using measures of descriptive statistics, including mean, standard deviation, frequency, and percentage. Comparisons between the two groups were made using an independent t-test and Chi-square test as required. A $P < 0.05$ was considered statistically significant.

Results

A total of 50 patients undergoing arthroscopic ACLR were included in the study and equally divided into Group A (ACLR with ramp lesion repair, n = 25) and Group B (isolated ACLR without ramp lesion, n = 25). The majority of patients were young adults aged 26–35 years, with a male predominance observed in both groups (Table 1).

Sports-related injury was the most common mechanism of injury in both groups. Delayed surgery (>6 months from injury) was more frequently observed in patients with ramp lesions (64%) compared to isolated ACL injuries (40%) (Table 2 and Fig. 1).

Preoperatively, both groups demonstrated significant knee instability with positive Lachman and pivot-shift tests. At 6 months follow-up, Group A showed superior post-operative stability, with higher rates of negative Lachman test (88% vs. 72%) and negative pivot-shift test (84% vs. 60%) compared to Group B. Residual pivot-shift positivity was lower in Group A

Table 4: Functional outcome scores at 6 months		
Parameter	**Group A (%)**	**Group B (%)**
Mean Lysholm score	93.6±4.8	88.9±6.2
Excellent Lysholm (≥95)	15 (60)	9 (36)
Good Lysholm (84–94)	8 (32)	10 (40)
Fair Lysholm (65–83)	2 (8)	6 (24)
IKDC Grade A (Normal)	14 (56)	8 (32)
IKDC Grade B (Nearly normal)	9 (36)	11 (44)
IKDC Grade C (Abnormal)	2 (8)	6 (24)
IKDC: International Knee Documentation Committee		

(16%) than Group B (40%) (P = 0.03) (Table 3 and Fig. 2).

Functional outcomes were better in patients undergoing ramp lesion repair. Group A demonstrated higher mean Lysholm scores compared to Group B (93.6 ± 4.8 vs. 88.9 ± 6.2). A greater proportion of patients in Group A achieved normal IKDC grades (56% vs. 32%), while abnormal IKDC grades were more common in Group B (24% vs. 8%) (Table 4).

Discussion

The present study demonstrated that meniscal ramp lesion repair performed during ACLR improved post-operative knee stability and functional outcomes. Most patients were young male adults with sports-related injuries, reflecting the typical epidemiological pattern of ACL tears. Delayed surgery was more common in patients with ramp lesions, supporting the concept that chronic ACL deficiency predisposes to secondary meniscocapsular injury. Similar findings were reported by Hatayama et al. [14], who observed higher instability rates in patients with ramp lesions.

Postoperatively, patients undergoing ramp lesion repair demonstrated better anterior and rotational stability, with lower residual Lachman and pivot-shift positivity compared to isolated ACLR. These findings support the biomechanical role of the posterior horn of the medial meniscus as a secondary stabilizer in ACL-deficient knees. Comparable biomechanical observations were reported by Li et al. [15], who demonstrated that ramp lesions increased anterior tibial translation and rotational instability, which improved following repair.

Functional outcomes were also superior in the ramp repair group, with higher Lysholm scores and better IKDC grades compared to isolated ACLR. In contrast, Liu et al. [16] reported no significant difference between repaired and unrepaired stable ramp lesions. However, their study evaluated only stable lesions, whereas the present study compared repaired ramp lesions with knees without ramp pathology, which may explain the differing outcomes.

The healing potential of ramp lesions has also been emphasized by DePhillipo et al. [17], who demonstrated superior healing rates in repaired lesions and improved post-operative stability in healed knees. Similarly, D'Ambrosi et al. [18] concluded that repair of unstable ramp lesions during ACLR improves knee function and stability. The findings of the present study further support the importance of systematic arthroscopic evaluation and appropriate management of ramp lesions during ACLR.

The strengths of the present study include its prospective design, systematic arthroscopic assessment, and objective evaluation of post-operative instability and functional outcomes. However, limitations include the relatively small sample size, short follow-up duration, and lack of randomization. Larger multicentric studies with longer follow-up are required to validate these findings.

Conclusion

Meniscal ramp lesion repair performed during ACLR improved post-operative knee stability and functional outcomes while reducing residual rotational laxity. Routine arthroscopic evaluation and appropriate management of ramp lesions during ACLR may improve post-operative knee stability and overall surgical outcomes.

Clinical Message

Early identification and repair of meniscal ramp lesions during ACLR may improve post-operative rotational stability and functional recovery.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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