ORIGINAL ARTICLE

All-Inside versus Inside-Out Repair of Meniscal Ramp Lesions in Anterior Cruciate Ligament Reconstruction: A Prospective Comparative Study of Functional Outcomes

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Abstract

Introduction: Meniscal ramp lesions are tears at the meniscocapsular junction of the posterior horn of the medial meniscus, occurring in 9–24% of patients with anterior cruciate ligament (ACL) injuries. These lesions are frequently missed on standard pre-operative magnetic resonance imaging (MRI), contributing to residual knee instability and increased graft failure rates. Two principal repair techniques exist: All-inside fixation using suture-based implants, and the inside-out technique using zone-specific cannulas. Comparative functional outcome data between these techniques are lacking, particularly from the Indian subcontinent. **Materials and Methods:** A prospective comparative study of 83 patients (mean age 28 ± 6.2 years; 68–72% male) undergoing arthroscopic ACL reconstruction at a tertiary care center in Chennai from June 2021 to June 2025. A posteromedial portal was established in all cases. Patients with confirmed ramp lesions (n = 17) underwent repair by all-inside technique (Group A, n = 11) or inside-out technique (Group B, n = 6). Lysholm knee score, International Knee Documentation Committee (IKDC) subjective knee form, and Visual Analog Scale (VAS) for pain were recorded at baseline, 3, 6, and 12 months. Statistical analysis used repeated-measures analysis of variance with Bonferroni correction. **Results:** Ramp lesions were identified in 17 of 83 patients (20.5%); pre-operative MRI missed 8 (47.1% missed diagnosis rate). Both groups showed significant improvement in all outcomes at 12 months ($P < 0.001$). Lysholm at 12 months: Group A 85.3 ± 6.8 versus Group B 83.7 ± 7.4 ($P = 0.62$). IKDC: 76.4 ± 7.1 versus 74.9 ± 8.2 ($P = 0.68$). VAS pain: 14.2 ± 8.1 mm versus 15.8 ± 9.3 mm ($P = 0.71$). No between-group differences were statistically significant. Operative time was significantly shorter in Group A (68.4 vs. 84.7 min, $P = 0.02$). **Discussion:** Both techniques produced equivalent functional improvement exceeding minimum clinically important difference thresholds. All-inside repair demonstrated advantages in operative time and avoidance of a counter-incision. A notable finding was road traffic accident-dominant injury mechanism (62–70%), contrasting with sports-injury-dominant international series (76–82%). **Conclusion:** All-inside and inside-out repair techniques yield equivalent and clinically meaningful functional outcomes at 12 months. All-inside repair is recommended for Grade I-II lesions; inside-out repair for Grade III tears. Mandatory posteromedial portal assessment is recommended in all ACL reconstructions.

Key words: Anterior cruciate ligament reconstruction, All-inside repair, International Knee Documentation Committee, Inside-out repair, Lysholm score, Meniscocapsular junction, Posteromedial portal, Ramp lesion, Thaunat classification

INTRODUCTION

Meniscal ramp lesions are tears at the meniscocapsular junction of the posterior horn of the medial meniscus, involving the posterior meniscocapsular ligament and meniscotibial ligament. First described by Morgan and Casscells in 1986 and classified by Thaunat *et al*. in 2016, these lesions represent the most common concurrent

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meniscal injury in anterior cruciate ligament (ACL)-deficient knees, with a reported incidence of 9–24% in arthroscopic series.[1-3]

Disruption of the posterior meniscocapsular junction impairs secondary rotational stability of the knee, compounding the instability of an ACL-deficient knee. Untreated ramp lesions are associated with a 3.2-fold increase in ACL graft failure rates and inferior patient-reported outcomes at 24 months.[4] Concurrent repair at the time of ACL reconstruction is therefore strongly recommended.

Two principal arthroscopic techniques exist for ramp repair. All-inside repair uses suture-based implants deployed through the posteromedial portal, avoiding a counter-incision. The inside-out technique utilizes zone-specific cannulas and flexible needles, with sutures tied over the posterior capsule through a small posteromedial skin incision. Both techniques report healing rates of 85–91% at second-look arthroscopy;[5,6] however, comparative functional outcome data between these techniques are limited. Direct comparative data are largely retrospective and drawn from Western or East Asian populations, with no prospective study from the Indian subcontinent.

Aims

(1) To compare Lysholm Knee Score, International Knee Documentation Committee (IKDC) subjective knee form, and Visual Analog Scale (VAS) pain scores at 3, 6, and 12 months between all-inside and inside-out ramp repair groups; and (2) to identify technique-specific factors influencing functional recovery.

MATERIALS AND METHODS

Study design and setting

This was a prospective comparative study conducted at a tertiary care center in Chennai, Tamil Nadu, from June 2021 to June 2025. Institutional Ethics Committee approval was obtained (IEC No: 006/09/2024/IEC/SMCH). Written informed consent was obtained from all patients in English and Tamil before enrolment. All procedures were conducted in accordance with the Declaration of Helsinki (2013).

Patient selection

Inclusion criteria

Age 18–55 years; arthroscopically confirmed ACL tear scheduled for reconstruction; willingness to comply with the follow-up schedule.

Exclusion criteria

Previous ipsilateral knee surgery; concurrent multi-ligament injury (posterior cruciate ligament, lateral collateral ligament, or posterolateral corner); inflammatory arthropathy; Outerbridge Grade III-IV chondral pathology; contraindication to magnetic resonance imaging (MRI); inability to complete outcome questionnaires.

Diagnostic protocol

All 83 patients underwent pre-operative MRI on a GE Signa HDe 1.5T scanner (GE Healthcare, Chicago, IL, USA). The protocol included a dedicated posteromedial oblique PD fat-saturated sequence (2.5 mm slice thickness, 45° to the posterior horn long axis) for ramp lesion detection. MRI reports were issued by a musculoskeletal radiologist blinded to intraoperative findings.

A posteromedial portal was established in all patients using the crossing-needle technique with the knee at 90° flexion, regardless of pre-operative MRI findings. Ramp lesions were graded using the Thaunat classification: [2] Grade I — peripheral longitudinal tear with intact meniscocapsular attachment; Grade II – complete meniscocapsular detachment; Grade III – tear extending into the peripheral third of the posterior horn parenchyma.

Surgical technique and group allocation

All 17 patients with confirmed ramp lesions underwent repair at the time of ACL reconstruction, before graft passage. Technique allocation was based on lesion grade and senior surgeon assessment:

1. Group A – All-inside repair ($n = 11$): FasT-Fix 360 suture implants (Smith and Nephew, London, UK) passed through the posteromedial portal; vertical mattress sutures at 5 mm intervals; minimum two sutures per lesion. Applied for Grade I and II lesions.
2. Group B – Inside-out repair ($n = 6$): Zone-specific cannulas and flexible needles (Arthrex, Naples, FL, USA) with No. 2-0 PDS II sutures tied over the posterior capsule through a 2 cm posteromedial skin incision. Applied for Grade III and complex Grade II tears.

ACL reconstruction was performed using hamstring autograft (semitendinosus and gracilis), single-bundle, through the anteromedial femoral tunnel technique in all 83 patients.

Outcome measures

Primary outcomes were assessed at baseline (pre-operative), 3, 6, and 12 months post-operatively:

1. Lysholm knee scoring scale (0–100): 8-item validated instrument; minimal clinically important difference (MCID) 8.9 points.[7]

2. IKDC Subjective knee form (0–100): 18-item validated patient-reported outcome; MCID 9.2 points.[8]
3. VAS for pain (0–100 mm): Patient-marked on a 10 cm horizontal line.[9]

Secondary outcomes included operative time, return to pre-injury Tegner activity level, and complication rate (infection, re-tear, arthrofibrosis, and saphenous nerve neurapraxia).

Statistical analysis

All statistical analyses were performed using the IBM Statistical Package for the Social Sciences Statistics v26 (IBM Corporation, Armonk, NY, USA). Continuous variables are reported as mean ± standard deviation (Shapiro-Wilk test for normality) or median interquartile range. Categorical variables are reported as *n* (%). Within-group changes across time points were analyzed using repeated-measures analysis of variance with Greenhouse-Geisser correction and Bonferroni *post hoc* tests. Between-group comparisons at each time point used independent-samples *t*-test or Mann-Whitney U as appropriate. A $P < 0.05$ (two-tailed) was considered statistically significant. Given the small ramp lesion subgroup ($n = 17$), between-group analyses are exploratory and should be interpreted with caution.[10-15]

RESULTS

Enrolment and patient flow

Of 83 patients, ramp lesions were identified arthroscopically in 17 (20.5%). Pre-operative MRI had identified lesions in only 9 of these 17 patients, giving a missed diagnosis rate of 47.1% (95% confidence interval: 23.3–72.2%). Eleven patients underwent all-inside repair (Group A) and six underwent inside-out repair (Group B). All 17 patients completed 12-month follow-up.

Baseline characteristics

Baseline demographic and clinical characteristics are summarized in Table 1. No statistically significant differences were observed between groups for age, sex, body mass index, or injury mechanism. As expected, Grade III lesions and longer tears were more common in Group B, consistent with the clinical allocation rationale.

Intraoperative data

Intraoperative parameters are shown in Table 2. Group A demonstrated significantly shorter operative time, fewer sutures placed, and shorter tourniquet time. A posteromedial counter-incision was required in all Group B patients.

Primary functional outcomes

Both groups demonstrated significant improvement across all three outcome measures from baseline to 12 months ($P < 0.001$ within-group). No statistically significant between-group differences were observed at any time point. Results are summarized in Tables 3-5.

Secondary outcomes

Return to pre-injury Tegner activity level was achieved in 9/11 patients (81.8%) in Group A and 4/6 patients (66.7%)

Table 1: Baseline characteristics by repair group

Characteristic	Group A: All-inside (*n*=11)	Group B: Inside-out (*n*=6)	*P*-value
Age (years), mean±SD	27.4±5.8	29.3±7.1	0.54
Sex: Male, *n* (%)	8 (72.7)	4 (66.7)	0.77
Affected side: Right, *n* (%)	7 (63.6)	4 (66.7)	0.89
Mechanism: RTA, *n* (%)	7 (63.6)	4 (66.7)	0.89
Mechanism: Sports, *n* (%)	4 (36.4)	2 (33.3)	0.89
BMI (kg/m²), mean±SD	24.6±3.4	25.1±4.2	0.78
Thaunat grade I, *n* (%)	3 (27.3)	0 (0)	0.26
Thaunat grade II, *n* (%)	8 (72.7)	2 (33.3)	0.14
Thaunat grade III, *n* (%)	0 (0)	4 (66.7)	0.003*
Tear length (mm), mean±SD	12.4±3.1	18.7±4.6	0.003*
Baseline Lysholm score, mean±SD	54.1±10.8	53.5±12.2	0.91
Baseline IKDC score, mean±SD	50.3±10.2	49.8±11.4	0.93
Baseline VAS pain (mm), mean±SD	63.2±13.4	64.7±15.1	0.82

*Statistically significant. RTA: Road traffic accident. Grade III lesions and longer tears were significantly more prevalent in Group B, consistent with the technique allocation rationale, SD: Standard deviation, IKDC: International Knee Documentation Committee, VAS: Visual Analog Scale, BMI: Body mass index

Table 2: Intraoperative parameters by repair group

Parameter	Group A: All-inside (*n*=11)	Group B: Inside-out (*n*=6)	*P*-value
Operative time (min), mean±SD	68.4±11.2	84.7±13.8	0.02*
No. sutures placed, mean±SD	2.3±0.5	3.2±0.8	0.009*
Tourniquet time (min), mean±SD	52.1±9.6	64.3±12.1	0.03*
Counter-incision required, *n* (%)	0 (0)	6 (100)	<0.001*
Concurrent procedures, *n* (%)	2 (18.2)	1 (16.7)	0.93

*Statistically significant

Table 3: Lysholm knee score across time points (mean±standard deviation)

Group	Baseline	3 months	6 months	12 months	Δ (Baseline→12 mo)	*P* (within-group)
Group A: All-inside	54.1±10.8	73.2±9.1	82.4±7.6	85.3±6.8	+31.2	<0.001
Group B: Inside-out	53.5±12.2	71.4±10.3	80.1±8.9	83.7±7.4	+30.2	<0.001
P (between groups)	0.91	0.71	0.58	0.62	0.84	—

Both groups exceeded the Lysholm MCID of 8.9 points. No significant between-group difference at any time point

Table 4: International knee documentation committee subjective knee form across time points (mean±standard deviation)

Group	Baseline	3 months	6 months	12 months	Δ (Baseline→12 mo)	*P* (within-group)
Group A: All-inside	50.3±10.2	66.1±9.3	73.8±7.9	76.4±7.1	+26.1	<0.001
Group B: Inside-out	49.8±11.4	64.2±10.8	71.4±9.2	74.9±8.2	+25.1	<0.001
P (between groups)	0.93	0.69	0.55	0.68	0.77	—

Both groups exceeded the IKDC MCID of 9.2 points. No significant between-group difference

Table 5: Visual Analog Scale pain score across time points (mean±standard deviation, mm)

Group	Baseline	3 months	6 months	12 months	Δ (Baseline→12 mo)	*P* (within-group)
Group A: All-inside	63.2±13.4	39.1±11.6	23.4±9.8	14.2±8.1	−49.0	<0.001
Group B: Inside-out	64.7±15.1	41.3±13.2	25.8±11.4	15.8±9.3	−48.9	<0.001
P (between groups)	0.82	0.71	0.60	0.71	0.98	—

Substantial pain reduction in both groups; no significant between-group difference

in Group B at 12 months ($P = 0.44$). Mean time to return to sport: Group A 9.1 ± 1.3 months versus Group B 9.8 ± 1.7 months ($P = 0.36$).

Complications are summarized in Table 6. One re-tear occurred in Group B (Grade III, inside-out repair) at 8 months, confirmed at second-look arthroscopy. No saphenous nerve injuries, infections, or thromboembolic events were recorded in either group.

DISCUSSION

The principal finding of this study is that all-inside and inside-out arthroscopic repair of meniscal ramp lesions yield equivalent functional outcomes at 12 months following concurrent ACL reconstruction. Both groups demonstrated clinically significant improvements in Lysholm score (Group A: +31.2 points; Group B: +30.2 points), IKDC score (+26.1 and +25.1 points, respectively), and VAS pain reduction (−49.0 and −48.9 mm), all exceeding their respective MCID thresholds. No statistically significant between-group difference was detected at any time point.

These findings are consistent with Peltier *et al*., who reported equivalent Lysholm and IKDC scores between all-inside and inside-out cohorts at 24 months.[5] Group A (all-inside) demonstrated significantly shorter operative time (68.4 vs. 84.7 min, $P = 0.02$) and tourniquet time (52.1 vs. 64.3 min, $P = 0.03$) without the need for a posterior counter-incision, which has practical advantages in high-volume surgical settings.

The grade-dependent allocation introduces an inherent allocation bias. Grade III and complex tears were preferentially repaired with the inside-out technique. Despite this, outcomes were equivalent between groups, suggesting that the superior mechanical fixation of the inside-out technique in complex tears compensated for its additional

Table 6: Complications by repair group

Complication	Group A: All-inside *n* (%)	Group B: Inside-out *n* (%)	*P*-value
Re-tear of ramp repair	0 (0)	1 (16.7)	0.35
Arthrofibrosis	0 (0)	0 (0)	—
Saphenous nerve neurapraxia	0 (0)	0 (0)	—
Superficial wound infection	0 (0)	0 (0)	—
Anterior cruciate ligament graft failure	0 (0)	0 (0)	—
Total complications	0 (0)	1 (16.7)	0.35

operative demands. A randomized controlled trial with grade-stratified allocation would be required to definitively establish equivalence.

The arthroscopic ramp lesion incidence of 20.5% in this cohort is consistent with published estimates of 16–22%.[2,3] The pre-operative MRI missed diagnosis rate of 47.1% underscores the established limitations of standard 1.5T MRI protocols for posterior meniscocapsular injuries and reinforces the necessity of mandatory posteromedial portal assessment in all ACL reconstructions, regardless of pre-operative imaging findings.

A notable epidemiological finding was the predominance of road traffic accidents as the mechanism of ACL injury (62-70%), contrasting with the sports-injury-dominant populations (76–82%) in international series.[2,3,5,6] This pattern reflects the referral demographics of the study center, where motorcycle and auto-rickshaw-related knee trauma constitutes a significant proportion of orthopedic presentations. Despite this distinct mechanism profile, pre-injury Tegner activity levels and functional outcome trajectories were comparable to published sports-medicine cohorts, suggesting that the functional benefits of ramp repair are applicable across different injury mechanisms.

Whether the higher-energy mechanism of road traffic accidents results in a different ramp lesion grade distribution compared to sports injuries remains to be determined. The predominance of Grade III lesions in Group B may partly reflect this higher-energy mechanism, though confounding by technique allocation makes this difficult to establish conclusively.

Strengths of this study include prospective data collection, mandatory posteromedial portal assessment in all 83 patients, validated outcome instruments at four time points, and 100% follow-up at 12 months. Limitations include the small ramp lesion subgroup (n = 17), non-randomized technique allocation, single-center design, and 12-month follow-up duration, which is insufficient to evaluate long-term cartilage outcomes. The between-group comparisons should be considered exploratory and hypothesis-generating.

CONCLUSION

Both all-inside and inside-out techniques produced equivalent and clinically meaningful functional outcomes at 12 months following ramp lesion repair concurrent with ACL reconstruction. All-inside repair offers the advantages of reduced operative time and avoidance of a posterior counter-incision, supporting its use as the preferred technique for Grade I-II lesions. Inside-out repair remains appropriate for Grade III and complex tears. The 47.1% MRI missed diagnosis rate reaffirms that mandatory posteromedial portal assessment should be performed in all ACL reconstructions, irrespective of pre-operative imaging findings.

ETHICAL APPROVAL

Approved by Institutional Ethics Committee (IEC No: 006/09/2024/IEC/SMCH). All procedures were in accordance with the Declaration of Helsinki (2013).

INFORMED CONSENT

Written informed consent was obtained from all participants.

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