Medial Posterior Tibial Slope Predicts Ramp Lesion Healing Failure After All-Inside Device Repair in Anterior Cruciate Ligament Reconstruction: A Second-Look Arthroscopic Study

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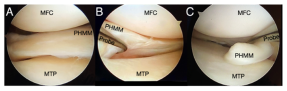
INTRODUCTION: Ramp lesions concurrent with ACL injuries increase knee instability and require treatment during ACL reconstruction. However, healing outcomes and associated factors remain unclear. This study evaluated arthroscopic healing assessment and 2-year clinical outcomes following ramp lesion repair during ACL reconstruction.

METHODS: Patients undergoing primary ACL reconstruction with concurrent ramp lesion treatment between 2016 and 2022 were retrospectively reviewed. Unstable ramp lesions were repaired using all-inside devices, while stable lesions received rasping only. Second-look arthroscopy was performed at a mean of 18.9 months postoperatively. Healing status was classified as complete healing, incomplete healing, or failed healing (Figure 1). Clinical outcomes were assessed using Lysholm score and Knee injury and Osteoarthritis Outcome Score (KOOS) preoperatively and at 2-year follow-up. ACL graft failure and residual pivot shift were evaluated throughout follow-up. Comparisons were made among the three healing groups. Factors related to healing failure were analyzed using univariate analysis.

RESULTS: Sixty-six patients were included. Of 58 patients with unstable ramp lesions, 33 (56.9%) achieved complete healing, 14 (24.1%) incomplete healing, and 11 (19.0%) failed healing. Eight patients had stable ramp lesions, all achieving successful healing (Table 1). All three groups showed comparable improvements in Lysholm and KOOS scores at 2-year follow-up. There was no significant difference in ACL graft failure and residual pivot shift rates among the three groups. In univariate analysis, medial posterior tibial slope (MPTS) was identified as the only significant predictor of healing failure (Table 2, 3). ROC analysis identified MPTS ≥6° as optimal cutoff for predicting healing failure (sensitivity 90.9%, specificity 62.2%). Using this threshold, patients with MPTS ≥6° showed significantly different healing outcomes compared to those with MPTS <6° (66.7% vs 45.8% complete healing, 29.2% vs 12.5% incomplete healing, 4.2% vs 41.7% failed healing for MPTS <6° vs ≥6°, respectively; P < 0.01).

DISCUSSION AND CONCLUSION: Second-look arthroscopy demonstrates satisfactory healing outcomes in unstable ramp lesions treated with all-inside repair devices during ACL reconstruction, with 56.9% achieving complete healing, 24.1% incomplete healing, and 19.0% failed healing. Increased MPTS was identified as the only significant predictor of healing failure. These findings highlight the importance of achieving successful ramp lesion repair for optimal knee stability post-ACL reconstruction and suggest that MPTS should be considered in preoperative risk assessment and surgical decision-making. Further long-term studies are warranted to fully understand the clinical implications of these healing outcomes.

Figure. 1 Second-look arthroscopic findings



Representative arthroscopic images showing the healing status criteria. (A) Complete healing, (B) incomplete healing, (C) failed healing, and MFC, medial femoral condyle; MTP, medial tibial plateau; PHMM, posterior horn of the medial meniscus

Table. 1 Healing status according to tear types

Tear Type	Cases	Completely Healed n (%)	Incompletely Healed n (%)	Failed Healing: Failed Original site n (%)	Failed Healing: Newly formed tear n (%)	Prolapsed anchor n (%)
Unstable						
1	20	11 (55.0)	5 (25.0)	0 (0)	4 (20.0)	2 (10.0)
2	6	4 (66.7)	1 (16.7)	1 (16.7)	0 (0)	1 (16.7)
3	12	9 (75.0)	3 (25.0)	0 (0)	0 (0)	4 (33.3)
4	12	6 (50.0)	4 (33.3)	2 (16.7)	0 (0)	1 (8.3)
5	8	3 (37.5)	1 (12.5)	4 (50.0)	0 (0)	3 (37.5)
Total	58	33 (56.9)	14 (24.1)	7 (12.1)	4 (6.9)	11 (19.0)
Stable						
1	2	2 (100)	0 (0)	0 (0)	0 (0)	–
2	2	1 (50.0)	1 (50.0)	0 (0)	0 (0)	–
3	4	2 (50.0)	2 (50.0)	0 (0)	0 (0)	–
Total	8	5 (62.5)	3 (37.5)	0 (0)	0 (0)	–

Table 2. Comparison of Preoperative Characteristics between Healing Status

Characteristics	Complete healing (n = 33)	Incomplete healing (n = 14)	Failed healing (n = 11)	P value
Patient demographics				
Age, y	21.1 ± 8.4	28.1 ± 11.5	23.2 ± 10.2	0.075
Sex, female	21 (63.6)	10 (71.4)	7 (63.6)	0.867
BMI, kg/m²	21.7 ± 2.2	22.4 ± 2.3	21.8 ± 3.1	0.675
Time from injury to surgery, weeks	20.2 ± 6.9	17.9 ± 6.2	17.5 ± 6.5	0.369
MPTS, deg	4.4 ± 2.6 (95%CI: 2.5–6.3)	5.6 ± 2.5 (95%CI: 4.6–6.6)	7.5 ± 2.7† (95%CI: 5.7–9.3)	0.020
LPTS, deg	6.1 ± 2.5	6.2 ± 2.4	6.9 ± 2.9	0.338
Preoperative findings				
ATT, mm	6.2 ± 2.2	6.1 ± 1.5	6.0 ± 1.8	0.931
Pivot shift grade distribution				0.968
Grade 0	0 (0)	0 (0)	0 (0)	
Grade 1	6 (18.2)	3 (21.4)	1 (9.1)	
Grade 2	15 (45.5)	6 (42.9)	5 (45.5)	
Grade 3	12 (36.4)	5 (35.7)	5 (45.5)	
Lysholm score	78.4 ± 16.8	85.7 ± 14.5	78.1 ± 17.3	0.556
KOOS				
Pain	80.6 ± 14.1	77.8 ± 31.9	79.2 ± 14.7	0.947
Symptoms	75.5 ± 16.4	78.6 ± 32.6	79.4 ± 20.7	0.905
Activities of daily living	91.9 ± 7.8	85.3 ± 34.5	90.5 ± 10.5	0.719
Sport/recreation	50.7 ± 30.8	54.4 ± 30.6	58.6 ± 27.4	0.954
Quality of life	47.1 ± 21.2	43.0 ± 21.8	42.4 ± 27.4	0.864
Tear Type distribution				0.407
Type 1	11 (33.3)	5 (35.7)	4 (36.4)	
Type 2	4 (12.1)	1 (7.1)	1 (9.1)	
Type 3	9 (27.3)	3 (21.4)	0 (0)	
Type 4	6 (18.2)	4 (28.6)	2 (18.2)	
Type 5	3 (9.1)	1 (7.1)	4 (36.4)	
Number of fixation devices	3 (2–3)	2.5 (2–3.25)	3 (2–3)	0.866
Surgical procedures				
Fibrin clot augmentation	21 (63.6)	8 (57.1)	6 (54.5)	0.834
Combined ALL reconstruction	9 (27.3)	3 (21.4)	2 (18.2)	0.800

†Data are presented as means ± SDs.
‡For MPTS, 95% confidence intervals are additionally shown.
§Data are presented as n (%).
¶Data are presented as medians (interquartile ranges).
#Overall distribution comparison using Fisher's exact test
*Statistically significant (P < 0.05)
**Statistically significant difference (P = 0.025) by Bonferroni post-hoc test
ALL, anterolateral ligament; ATT, anterior tibial translation; BMI, body mass index; CI, confidence intervals; KOOS, Knee injury and Osteoarthritis Outcome Score; LPTS, lateral posterior tibial slope; MPTS, medial posterior tibial slope

Table 3. Comparison of Postoperative Outcomes between Healing Groups

Outcomes	Complete healing (n = 33)	Incomplete healing (n = 14)	Failed healing (n = 11)	P value
Clinical outcomes at 2nd-look				
ATT†, mm	1.2 ± 1.4	1.3 ± 1.7	2.0 ± 1.3	0.225
Residual pivot shift‡				0.122#
Grade 1	2 (6.1)	1 (7.1)	3 (27.3)	
Grade 2	0 (0)	0 (0)	0 (0)	
Grade 3	0 (0)	0 (0)	0 (0)	
Subsequent meniscal or graft failure‡	1 (3.0)	0 (0)	0 (0)	1.000#
ACL reinjury	4 (12.1)	1 (7.1)	4 (36.4)	0.096#
PROMs at 2 years				
Lysholm score†	94.6 ± 7.2	94.0 ± 4.1	96.0 ± 3.8	0.791
KOOS‡				
Pain	95.3 ± 7.2	87.9 ± 29.4	88.8 ± 22.2	0.745
Symptoms	95.6 ± 4.9	82.1 ± 28.3	86.4 ± 23.2	0.443
Activities of daily living	98.8 ± 2.4	89.6 ± 29.8	93.9 ± 21.9	0.608
Sport/recreation	95.6 ± 4.2	80.5 ± 28.9	87.6 ± 23.8	0.377
Quality of life	90.7 ± 8.8	77.3 ± 28.3	82.8 ± 25.1	0.492

†Data are presented as means ± SDs.
‡Data are presented as n (%).
#Overall distribution comparison using Fisher's exact test
ACL, anterior cruciate ligament; ATT, anterior tibial translation; KOOS, Knee injury and Osteoarthritis Outcome Score; PROMs, patient-reported outcomes