

Short-Term Outcomes After Treatment of Isolated Hidden Meniscal Ramp Lesions

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Background: Ramp lesions are encountered in 16% to 24% of all anterior cruciate ligament (ACL) ruptures. However, isolated ramp lesions without a ruptured ACL have also been reported.

Purpose: To evaluate outcomes after type 3 hidden ramp lesions without ACL rupture were treated with all-inside sutures passed through the standard anterior portal.

Study Design: Case series, Level of evidence, 4.

Methods: Included were 41 patients (26 female; 63.4%) with isolated type 3 ramp lesions who underwent surgery between January 2017 and January 2019. Patients with concomitant lateral meniscal injuries and revision meniscal surgeries were excluded. We retrospectively recorded patient age, sex, and body mass index (BMI), as well as follow-up periods, comorbidities, and postoperative and early midterm complications. The Lysholm, visual analog scale (VAS) for pain, and International Knee Documentation Committee (IKDC) scores were compared preoperatively to final follow-up. In addition, patients were classified as having either a sedentary or active lifestyle according to Sedentary Behavior Research Network (SBRN) criteria. The Shapiro-Wilk test was used to evaluate the normality of the data, and the Wilcoxon and Mann-Whitney *U* tests were used to compare preoperative and postoperative outcome scores. The Spearman test was employed to evaluate the correlation between patient variables.

Results: The mean follow-up period was at 37.6 (range, 25-49) months. A total of 17 patients (41.46%) had a sedentary lifestyle based on SBRN criteria. All scores improved significantly from preoperatively to final follow-up (VAS, from 8.43 ± 1.53 to 2.34 ± 2.9 ; Lysholm, from 47.73 ± 17.02 to 85.37 ± 14.01 ; and IKDC, from 27.12 ± 14.81 to 85.32 ± 8.78 ; $P < .001$ for all). Although no significant relationship was established between patient activity level and postoperative Lysholm and IKDC scores, an inverse correlation was observed between BMI and Lysholm ($r = -0.9906$) and BMI and IKDC ($r = -0.9402$).

Conclusion: Satisfactory postoperative clinical results were obtained in patients with type 3 ramp lesions not accompanied by ACL rupture who were treated with all-inside suturing through standard anterior portals.

Keywords: ACL; hidden lesion; meniscus; ramp; tear

The name *ramp lesion* comes from the ramp-like appearance of the posteromedial area of the meniscus.¹³ The lesion is defined as the separation of the posterior horn of the medial meniscus (PHMM) from the joint capsule or the rupture of the meniscotibial ligament (MTL).²⁷ Ramp lesions are encountered in 16% to 24% of all anterior cruciate ligament (ACL) ruptures.¹¹ There are hypotheses that aim to explain the reason for this frequent co-occurrence, with traction applied to the capsule by the branch of the contracting semimembranosus tendon adhering to the posteromedial capsule to prevent anterior translation of the tibia after ACL rupture.^{6,27} However, isolated ramp lesions without ruptured ACL have been reported as well.¹⁸ In this latter study, the authors suggested that ramp lesions occur

due to longitudinal splits and degenerations on the ACL, although they did not mention the types of ramp lesions treated.¹⁸

Ramp lesions are divided into 5 types based on the affected structures, tear pattern, tear thickness, MTL disruption, and instability.^{13,29} Standard knee magnetic resonance imaging (MRI) is taken with the knee in full extension, causing the meniscocapsular space to become narrower, thus making it difficult to diagnose a ramp lesion on preoperative MRI scans.²⁷ For this reason, diagnosing the ramp lesion with a probe examination during arthroscopy is recommended.^{13,27} Since the combination of partial inferior PHMM tear and MTL tear (type 3) cannot be visualized with the standard and transnotch arthroscopic approach, the lesion is also referred to as a hidden lesion.^{13,27,29} It has been reported that hidden lesions are the least detectable type of ramp lesions due to the difficulty of arthroscopic imaging, and they are not always

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diagnosed successfully with standard preoperative imaging methods.^{13,27,29}

The aim of our study was to evaluate the results of type 3 hidden ramp lesions with concomitant PHMM and MTL tears that were not accompanied by an ACL rupture, treated with all-inside sutures passed through the standard anterior portals. It was hypothesized that satisfactory clinical results could be obtained with the all-inside repair method applied through standard anterior portals in ramp lesions that cannot always be detected with preoperative imaging methods but are diagnosed with diagnostic arthroscopy and unaccompanied by an ACL rupture.

METHODS

Ethics committee approval and informed consent from all study patients were obtained for our retrospective study. Tenderness of the medial joint was detected in all these patients, who did not have a history of acute trauma, had medial knee pain, and reported increased pain especially when descending stairs and during deep flexion. Nonoperative treatment (nonsteroidal anti-inflammatory drugs [NSAIDs], physical therapy, prevention of hyperflexion, and use of brace) for 3 months was recommended for patients whose preoperative MRI scans did not demonstrate any pathology that could explain the medial knee pain. Exclusion criteria were concomitant ligament rupture, concomitant lateral meniscal pathology, and revision knee arthroscopy surgery.

Surgical Technique and Postoperative Rehabilitation

Standard knee arthroscopy was performed by the same senior author (R.A.) in all patients in the supine position and under a tourniquet. Standard knee anterolateral and anteromedial arthroscopy portals were created. All intra-knee structures were examined using a 30° arthroscope during standard diagnostic arthroscopy, and no ACL rupture was detected. The transnotch approach was performed routinely, as none of the patients showed meniscocapsular separation. The PHMM was evaluated in detail with the help of a probe, and medial release was performed with outside-in percutaneous pie crusting for ease of working in the medial joint space among patients with instability.²⁴ After pulling the posterior horn of the meniscus forward with the probe, we observed that the MTL was torn and that there was a vertical partial rupture on the inferior aspect of the PHMM (Figure 1).

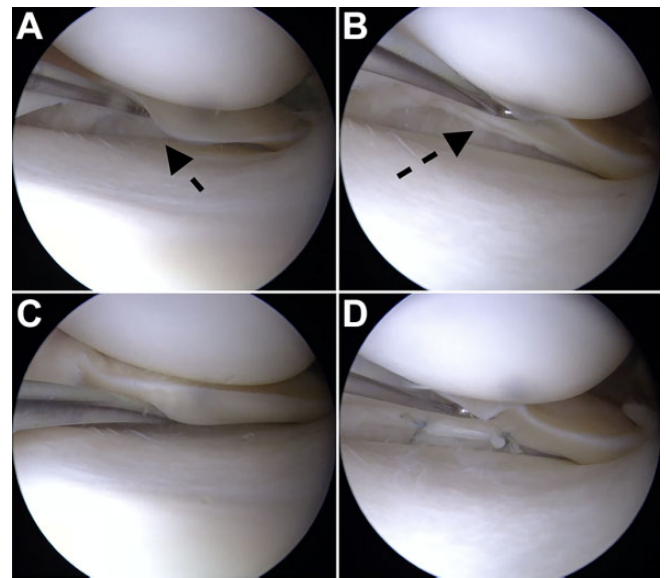


Figure 1. View of a left knee on 30° arthroscope advanced from the anterolateral portal. (A) Type 3 hidden ramp lesion with medial meniscotibial ligament tear (arrow). (B) Medial meniscotibial ligament tear and partial inferior meniscal tear (arrow). (C) Medial meniscal mobility is increased. (D) Type-3 ramp lesion repaired with 2 all-inside sutures.

The rupture sites were revascularized to aid biological healing using a 90° diamond meniscal rasp (Smith & Nephew) and a 4.5 mm shaver (Dyonics Powermax; Smith & Nephew). All-inside sutures (FAST-FIX 360° meniscal repair system; Smith & Nephew) were placed with vertical mattress configuration; the first anchor was inserted from the inferior aspect of the meniscus, entering through the meniscocapsular junction, while the second anchor was placed through the meniscus.⁷ While the anterolateral portal was used as the visualization portal, the anteromedial portal was used as the working portal, and the tears were fixed with a sufficient number of all-inside sutures with 3 to 5 mm spacing (Figure 1D). After the repair, PHMM stability was evaluated again with the probe. A bone marrow venting procedure was performed in all patients at the end of the surgery to provide biological augmentation.¹⁹

Patients were allowed full weightbearing progressively for the first 3 weeks after surgery. Jogging was allowed in week 12 and full activity at 6 months. All patients were followed up with postoperatively at 3 and 6 weeks; at 3, 6, and 12 months; and every year thereafter. During follow-up, meniscal healing was evaluated with the Barrett

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criteria,^{4,29} according to which a repaired meniscus is considered healed if there were no joint-line tenderness or effusion and if there were a negative McMurray test at the latest follow-up.

Data Collection

The patients' age, sex, body mass index (BMI), follow-up periods, comorbidities, and postoperative and early-mid-term complications were investigated retrospectively and recorded. The Lysholm, visual analog scale (VAS) for pain, and the International Knee Documentation Committee (IKDC) scores were recorded in the preoperative period and at the final follow-up of all patients. This final follow-up was conducted by an arthroscopic surgeon who was blinded to the patients' preoperative clinical and functional scores. In addition, patients were classified preoperatively as having either a sedentary or active lifestyle, according to criteria used in research related to sedentary behavior as established by the Sedentary Behavior Research Network (SBRN).³⁰

Statistical Analysis

Stata Statistical Software Release 13 (StataCorp) was used for descriptive and inferential analyses. The Shapiro-Wilk test was used to evaluate the normality of the data, the Wilcoxon test was used to compare preoperative and postoperative Lysholm and IKDC scores, and the Mann-Whitney *U* test to compare scores according to activity or sex. The Spearman test was employed for evaluating the correlation of the patients' BMI and age with the Lysholm and IKDC scores. A Spearman correlation coefficient (*r*) of greater than 0.7 was considered a very strong relationship, greater than 0.40 was considered a strong relationship, and less than 0.20 indicated no relationship. For all analyses, *P* < .05 was considered statistically significant.

RESULTS

In our study, 26 patients (63.4%) were females, and the average patient age was 34.4 (range, 19-57) years. No additional disease was observed in any of the patients, and none of the patients were lost to follow-up. The patients were followed up with for an average of 37.6 (range, 25-49) months. The patients had a mean BMI of 23.93 ± 3.98, and, based on the SBRN criteria,³⁰ 17 (41.46%) had a sedentary lifestyle (Table 1). Between January 2017 and January 2019, a total of 1342 arthroscopic knee surgeries were performed in our clinic, of which 41 were surgeries to treat a type 3 hidden ramp lesion without an ACL rupture. A ramp lesion could be diagnosed in only 13 patients (31.7%) on preoperative MRI scans (Figure 2).

Diagnostic knee arthroscopy was recommended and performed on 28 patients (68.3%) whose pain did not regress with conservative treatment. The mean ramp lesion length was 3.7 ± 1.17 mm. None of the patients had a tear on any other part of the meniscus. A minimum of 2 (*n* = 25, 60.9%) or maximum of 3 (*n* = 16, 39.1%) sutures were used to

TABLE 1
Patient Demographic Data^a

Characteristic	Value
Female sex	26 (63.4)
Age, y	34.4 ± 11.17 (19-57)
BMI, kg/m ²	23.93 ± 3.98 (17.13-39.52)
Final follow-up, months	37.6 ± 7.89 (25-49)
Sedentary lifestyle ^b	17 (41.46%)

^aData are reported as n (%) or mean ± SD (range). BMI, body mass index; SBRN, Sedentary Behavior Research Network.

^bAccording to SBRN criteria.³⁰

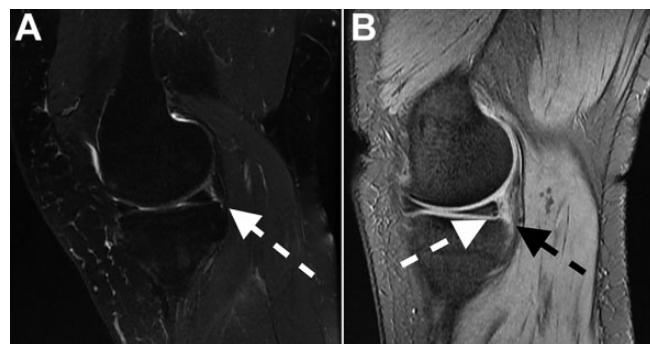


Figure 2. (A) Sagittal proton density fat-saturated MRI scan demonstrating medial meniscotibial ligament tear manifested by the disruption of the ligament with a high T2 signal intensity (white arrow) in a left knee. (B) Sagittal T2-weighted gradient MRI scan demonstrating the inferior partial medial meniscal tear manifested by the disruption of the ligament with a high T2 signal intensity (white arrow) and medial meniscotibial ligament disruption (black arrow) in a left knee. MRI, magnetic resonance imaging.

repair the ramp lesions. Ramp lesions were detected in the preoperative MRI scans of 13 patients, while the MRI sensitivity for type 3 hidden ramp lesion was 31.7%. No complications were observed in any of the patients and no revision arthroscopy was required.

At the final follow-up, all patients demonstrated meniscal healing according to Barrett criteria.⁴ Also, anterior drawer and Lachman tests of all patients were negative at the final follow-up. A statistically significant decrease (improvement) was found in the postoperative VAS scores compared with preoperative values (from 8.43 ± 1.53 to 2.34 ± 2.9; *P* < .001). In addition, statistically significant improvements were detected in the postoperative Lysholm and IKDC scores compared with preoperative values (Lysholm, from 47.73 ± 17.02 to 85.37 ± 14.01; IKDC, from 27.12 ± 14.81 to 85.32 ± 8.78; *P* < .001 for both); both are scoring systems that evaluate the functional results of patients during daily activities (Table 2).

No statistically significant relationship was established between the postoperative Lysholm and IKDC scores and patient activity level (*P* > .05). However, an inverse correlation was observed between patient BMI and the Lysholm

and IKDC scores ($r = -0.9906$ [BMI vs Lysholm] and -0.9402 [BMI vs IKDC]) (Figure 3). While statistically higher postoperative Lysholm values were detected in male patients ($P = .0314$), no significant relationship was observed between the IKDC score and sex ($P = .5150$).

DISCUSSION

The most important result of our study is that satisfactory postoperative clinical results can be obtained in type 3 ramp lesions with PHMM and MTL tear, and not accompanied by ACL rupture (mean Lysholm score, 85.37 ± 14.01 ; mean IKDC score, 85.32 ± 8.78), by treating with all-inside suturing through standard anterior portals. Only type 3 hidden ramp lesions without ACL rupture were included, and the preoperative MRI sensitivity for these lesions was 31.7%. In our study, the preoperative activity level of patients who had not been included in another study on ramp lesions in the literature was also evaluated, and no significant relationship was found between preoperative activity level and postoperative functional results ($P > .05$).

DePhillipo et al⁹ reported satisfactory Lysholm and IKDC scores in a study they performed on 2 groups in which isolated ACL reconstruction, and ACL reconstruction and ramp lesion, were treated together; no significant difference was found between the 2 groups (mean Lysholm score, 85 vs 86; mean IKDC score, 77 vs 78). Ramp lesions with a tear less than 1.5 cm in size during ACL reconstruction are considered stable, and it has been reported that clinical

outcomes are not improved with arthroscopic repair in such cases.²³ However, arthroscopic repair of unstable ramp lesions during ACL reconstruction has also been reported to improve healing in these lesions.¹⁶ Some studies have reported satisfactory postoperative clinical results after arthroscopic surgery.^{1,14,29} Almost all of these studies report the clinical outcomes of medial meniscal ramp lesions accompanied by ACL rupture. In our review, only the study of Jiang et al¹⁸ reported the results of 20 patients treated arthroscopically for an isolated ramp lesion of the medial meniscus without ACL rupture. In their study, the authors did not report the subtypes of ramp lesions but stated that they believed these ramp lesions were due to ACL degeneration that healed over time. The authors also reported a mean postoperative VAS score of 2.1 ± 1.4 and a mean Lysholm score of 85.7 ± 3.5 at the second-year follow-up.¹⁸ In our study, where the mean follow-up period was 37.6 months, the mean VAS score was 2.34 ± 2.9 , the Lysholm score was 85.37 ± 14.01 , and the mean IKDC score was 85.32 ± 8.78 . These results are in accordance with those of Jiang et al¹⁸. Although the authors did not mention the tear types and their treatment approach in their study, they reported that outcomes were perfect. We believe that this is due to the fact that the repair sites of all ramp lesions have greater blood flow for proper healing.

During arthroscopic ACL reconstruction, careful examination is recommended for medial meniscal ramp lesions, which can often be overlooked in young patients, chronic injuries, and accompanying lateral meniscal injuries.^{3,5} However, many studies report risk factors for the formation of a medial meniscal ramp lesion accompanying ACL rupture.^{20,22,28} In a study that included 3214 arthroscopically treated ACL rupture patients, Sonnery-Cottet et al²⁸ reported the prevalence of medial meniscal ramp lesion as 23.9%, while male sex, age below 30 years, chronic ACL rupture, and accompanying lateral meniscal injuries were found as risk factors for ramp lesions. In their systematic meta-analysis involving 8410 patients who underwent arthroscopic surgery for ACL rupture, Kunze et al²² reported that male sex, total ACL rupture, and the presence of posteromedial tibial edema on preoperative MRI scans were the risk factors for an accompanying ramp

TABLE 2
Preoperative and Postoperative VAS, Lysholm, and IKDC Scores^a

	Preoperative	Postoperative	P
VAS	8.44 ± 1.53 (5-10)	2.34 ± 2.90 (0-5)	<.001
Lysholm	47.73 ± 17.02 (19-95)	85.37 ± 14.01 (45-100)	<.001
IKDC	27.12 ± 14.81 (15-65)	85.32 ± 8.78 (71-100)	<.001

^aData are reported as mean ± SD (range). IKDC International Knee Documentation Committee; VAS, visual analog score.

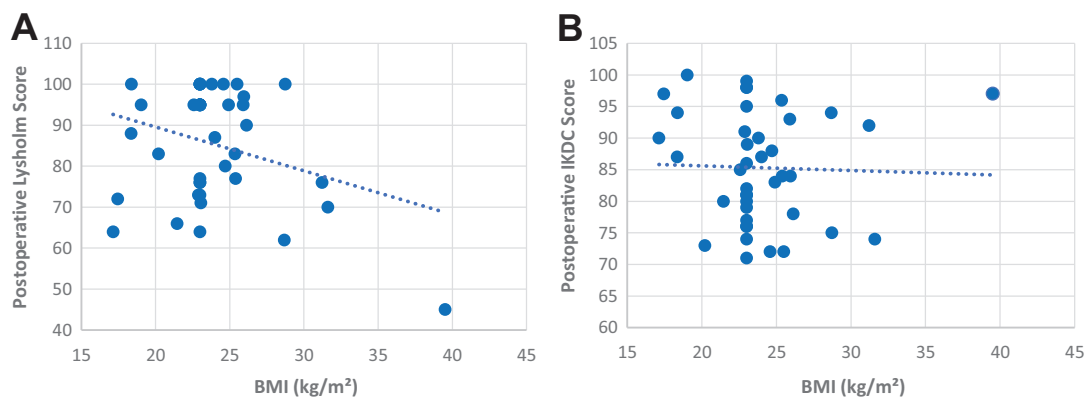


Figure 3. Relationship between BMI and postoperative (A) Lysholm and (B) IKDC scores. BMI, body mass index; IKDC, International Knee Documentation Committee.

lesion. In our study, however, none of the patients had an ACL rupture with an accompanying lateral meniscal tear. On the other hand, while 36.6% of the patients in our study were male, the mean age was 34.4 (range, 19-57) years.

It has been reported that rotatory instability and anterior translation are more common in ACL ruptures accompanied by medial meniscal ramp lesions.^{25,26} While ramp lesions are reported to be a risk factor for partial ACL ruptures to proceed to total ACL ruptures, arthroscopic repair is recommended for these tears.¹² The results of a study by DePhillipo et al¹⁰, in which 91 fellowship directors were included by filling out electronic questionnaires, suggested that more than 80% of participants had repaired unstable ramp lesions arthroscopically, while 66.7% of participants said they had used the all-inside technique. Heilpern et al¹⁷ performed a biomechanical evaluation in cadavers of all-inside sutures passed through the standard anterior portals, which is an all-inside method used in the arthroscopic treatment of ramp lesions of the medial meniscus, and reported that this technique provided reliable fixation. In our study, all patients were treated with all-inside sutures passed through the standard anterior portals and none required revision surgery.

Although it has been reported that MRI can be used with moderate sensitivity and excellent specificity in the preoperative detection of ramp lesions, it is recommended to perform posteromedial imaging with a transnotch approach during ACL reconstruction, even if there is no suspicion of ramp lesion in preoperative images.²¹ DePhillipo et al⁸ reported that preoperative MRI had a sensitivity of 48% in detecting ramp lesions. In another study, Arner et al² reported that ramp lesions could be detected with 53.9% to 84.6% sensitivity and 92.3% to 98.7% specificity with MRI, as evaluated by 3 different reviewers. In another study in which the subtypes of ramp lesions were not examined separately, Hatayama et al¹⁵ recounted that ramp lesions were diagnosed with preoperative MRI with a 71.7% sensitivity and a 90.5% specificity. In a meta-analysis, Bumberger et al⁵ reported that preoperative MRI had a sensitivity of 46% to 86% in diagnosing ramp lesion, whereas diagnostic accuracy of MRI for type 3 hidden ramp lesions was unclear. In our study, only type 3 hidden ramp lesions without ACL rupture were included, and the preoperative MRI sensitivity for these lesions was 31.7%.

Limitations

There were several limitations to our study. First, although the type 3 ramp lesions included in our study were observed to be unstable and larger than 1.5 cm on arthroscopic video recordings, the exact dimensions of the tear were not recorded. Second, another literature study reports isolated ramp lesions without ACL rupture,¹⁸ although the subtypes of ramp lesions observed in this study were not mentioned. All the isolated ramp lesions without ACL rupture in our study were type 3 ramp lesions, but the present results cannot explain why other subtypes were not observed. This was also a retrospective study of symptomatic patients, thus we do not know how many have concerning findings on MRI scan that are asymptomatic. Finally, as in many studies

reporting the clinical and functional results of isolated ramp lesions with treated ACL ruptures, our study also lacked long-term results, although our minimum follow-up period was 24 months.^{9,14,16,18,29}

Currently, we do not have a rational hypothesis about the mechanism of injury of isolated type 3 ramp lesions without ACL rupture, but future biomechanical and anatomic studies will provide a clearer answer to the question of whether ramp lesions occur before or after ACL ruptures.

CONCLUSION

Satisfactory postoperative clinical results were obtained in patients with type 3 ramp lesions not accompanied by ACL rupture who were treated with all-inside suturing through standard anterior portals. We recommend that careful and complete probe examination should be performed routinely, especially in those patients whose chronic medial knee pain cannot be explained by preoperative MRI scans.

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