


Management of Ramp Lesion in Common Meniscus Lesion: Repair or Conservative

Alhoi Lesley Davidson, Peter Giarso
Dr. Midiyato Suratani Naval Hospital, Tanjungpinang, Riau Archipelago, Indonesia

ABSTRACT

Ramp lesions are the most frequent intra-articular injuries associated with anterior cruciate ligament (ACL) ruptures and are often missed during diagnosis. They occur at the meniscocapsular junction of the posterior horn of the medial meniscus and may compromise knee stability. Magnetic resonance imaging (MRI) can identify ramp lesions but has limited sensitivity; therefore, arthroscopy remains the diagnostic gold standard. Treatment options include conservative management for stable tears and surgical repair for unstable or type IV–V lesions. Recent studies show no significant difference in long-term knee stability between repaired and unrepaired lesions; however, repaired lesions demonstrate faster functional recovery. Repair is particularly advised for patients in their productive years, especially athletes or individuals with high physical-activity demands requiring optimal knee stability. Appropriate radiologic evaluation combined with structured postoperative rehabilitation improves clinical outcomes and reduces recurrence. This review summarizes current evidence on the epidemiology, diagnosis, classification, and management strategies for ramp lesions commonly found in association with ACL-related meniscal injuries.

Keywords: Knee stability, meniscus, ramp lesion.

ABSTRAK

Lesi *ramp* merupakan lesi intraartikular yang paling sering ditemukan bersamaan dengan robekan *anterior cruciate ligament* (ACL) dan sering terlewatkan saat diagnosis. Lesi ini berlokasi pada hubungan meniskokapsular bagian posterior tanduk medial meniskus dan dapat menurunkan stabilitas lutut. Deteksi lesi *ramp* dapat dilakukan melalui *magnetic resonance imaging* (MRI) namun sering kurang sensitif, sehingga artroskopi menjadi *gold standard*. Pilihan tata laksana meliputi pendekatan konservatif pada lesi stabil dan perbaikan operatif pada lesi instabil atau tipe IV–V. Beberapa penelitian menunjukkan bahwa pemulihan fungsional tidak berbeda signifikan antara lesi yang diperbaiki dan yang tidak, namun lesi yang direparasi menunjukkan waktu pemulihan lebih cepat. Perbaikan disarankan pada pasien usia produktif, terutama atlet atau individu dengan aktivitas fisik tinggi yang memerlukan stabilitas lutut optimal. Integrasi evaluasi radiologis dan pendekatan rehabilitasi yang tepat dapat meningkatkan hasil fungsional dan menurunkan risiko cedera berulang. Artikel ini meninjau bukti terbaru mengenai diagnosis, klasifikasi, dan penatalaksanaan lesi *ramp* pada robekan meniskus yang berhubungan dengan ACL. **Alhoi Lesley Davidson, Peter Giarso. Tata Laksana Lesi *Ramp* pada Lesi Meniscus Umum: *Repair* atau Konservatif.**

Kata Kunci: Kestabilan lutut, meniskus, lesi *ramp*.

INTRODUCTION

The meniscus is made up of two fibrocartilaginous structures that are mostly composed of glycosaminoglycans (about 1%), type I collagen (22%), and water (65%–75%).[1] Patients with ruptured ACL frequently have meniscal lesions.[2] Based on data from ACL registries, meniscal lesions are associated with 47% to 61% of ACL ruptures. The posterior horn of the medial meniscus (MM) is the most often occurring intra-articular lesion linked to ACL ruptures. The type of MM lesion, known as meniscosynovial or meniscocapsular rips, may be difficult to identify arthroscopically from the anterior compartment.[3] A particular type of meniscal lesion associated with ACL rupture was first found by Strobel in 1998 and is known as a ramp lesion of the medial meniscus.[4] Hamberg originally described ramp lesions as a peripheral vertical rupture in the posterior horn of the medial or lateral meniscus with an intact body.[5] It was previously estimated that the incidence of ramp lesions in knees lacking an ACL was between 9.3% and 24%.[6] A

Alamat Korespondensi *Aldavidson3010@gmail.com*

study by Balazs, *et al*,. found that meniscal ramp lesions were prevalent in 157 (42%) of 372 patients with ACL injuries. Ramp lesions are referred to as hidden lesions because they are often missed during both arthroscopic examinations performed through regular portals and preoperative magnetic resonance imaging.[7,8] A Segond fracture, posteromedial tibial bone bruising, and pivot-shift-type bone bruising have all been linked to ramp lesions.[9] The meniscotibial ligament and meniscocapsular junction are essential to appropriate knee kinematics as they let the medial meniscus itself serve as an additional stabilizer against anterior tibial translation, which can protect the ACL from excessive load bearing. Ramp lesions, however, often occur around the omentum of ACL rupture because of this mechanistic relationship. This is due to sudden anterior tibial translation brought on by instability, which can raise meniscocapsular joint stress by more than 200%.[10]

DISCUSSION

Anatomy of Meniscus

The term "meniscus" is derived from the Latin word "meniskos," which means "crescent".[11] The meniscus is a fibrocartilage structure located on the lateral and medial aspects of the knee. The meniscus facilitates articulation between the concave femoral condyles and the flat tibial plateau. About two-thirds of the articular surface of the corresponding tibial plateau is covered by the meniscus, which has a roughly triangular cross-section. The meniscus is secured to the tibial plateau's subchondral bone by the meniscal horns. By transferring shear and tensile force from soft tissue to bone, these ligamentous structures minimize contact area. The posterior horn connects to the tibia just in advance of the area where the posterior cruciate ligament (PCL) inserts. The lateral meniscus is located just in front of the intercondylar eminence, within the anterior horn inserts on the tibia, and immediately posterior and lateral to the ACL insertion. The posterior horn attaches to the tibia between the PCL and the medial meniscus posterior horn insertion sites. The outer rim of the meniscus, referred to as the red zone, is thick and convex, while the inner border, or white zone, is concave, thin, and separated from the knee joint capsule.[12]

The posterior capsular junction of the medial meniscus is made up of the meniscotibial ligament in the inferior and the meniscocapsular ligament in the superior. Together with the posterior horn of the medial meniscus, they buffer the knee against anterior tibial translation and posteromedial rotation. The peripheral zone of the medial meniscus, also known as the red-red area, is where ramp lesions form and where the meniscocapsular and meniscotibial structures join to the posterior horn. Ramp lesions can occur with traumatic acute ACL injury or in cases of chronic ACL deficit in the knee, which can speed up tibial translation.[13]

Epidemiology

The majority of ramp lesions were reported in patients under 30 years. The incidence was 1.6 times higher in those over 30 years; it was 1.5 times higher in males than in females.[14,15] ACL-associated ramp lesions were equally common in children and adolescents as they were in adults.[16] Approximately 28% patients receiving ACL repair have meniscal ramp lesions.[17] Kim, *et al*., found that 95 (34.5%) of 275 patients who underwent ACL reconstruction suffered from ramp lesions.[18] Ramp lesions were also observed in patients undergoing ACL revision surgery, patients with concurrent lateral meniscus tears, and patients with preoperative side-to-side laxity greater than 6 mm.[19–21] Soccer is the most frequent cause of ramp lesions. Ramp lesions are more common in the right knee than the left knee.[22] The posterior horn of the medial meniscus is where meniscal lesions are most frequently found.[23] Medial meniscal tears are more likely in the context of chronic ACL injury, and medial ramp lesions are typically found when posteromedial tibial plateau bone bruising occurs.[20] According to a study by Bollen, the prevalence of medial meniscal ramp lesions was 9.3% in 183 patients having ACL reconstruction.[24] According to an arthroscopic analysis of 868 patients having ACL reconstruction, 16.6% had a ramp lesions.[25] Cases of ramp lesions confirmed in 2,156 arthroscopic reconstructions were 334 (15.5%).[26] Complete ACL tears, varus alignment, concurrent lateral meniscus injury, steep medial meniscal slope, contact sport injuries, deep posterior lateral femoral condyle, and steep medial tibial slope were other risk variables that were also mentioned.[27,28]

Classification

Ramp lesions are divided into five categories according to arthroscopy visibility, the layer involved, the anatomical location of the laceration, and other considerations **(Table 1)**.[29]

Table 1. Classification of ramp lesion and stability.[10,13]

Ramp Lesion Classifications		
Thaunat, *et al*.	Grief, *et al*.	Stability
Type 1: Meniscocapsular tear	Type 1: Meniscocapsular ligament tear	Stable
Type 2: Partial superior tear	Type 2: Partial superior peripheral posterior meniscus horn tear	Stable
Type 3: Partial inferior tear	Type 3A: Partial inferior peripheral posterior horn meniscus tear	Stable
	Type 3B: Meniscotibial ligament tear	Stable
Type 4: Complete tear	Type 4A: Complete peripheral posterior horn meniscal tear	Unstable
	Type 4B: Complete meniscocapsular junction tear	Unstable
Type 5: Double tear	Type 5: Peripheral posterior horn meniscal double tear	Unstable

1. Meniscocapsular lesion type I is characterized by a more peripheral position inside the synovial sheath and minimal movement upon probing.
2. Meniscocapsular lesion type II is stable, with partial upper lesions that move very little when prodded.
3. Meniscocapsular lesion type III is distinguished by considerable probing motion due to partial meniscotibial ligament tears.
4. Meniscocapsular lesion type IV is characterized by complete rips in the red-red zone and high mobility upon probing.
5. Meniscocapsular lesion type V is distinguished by two lesions.

DIAGNOSIS

History and Physical Examination

Characteristics of the patient may include time since ACL damage, male sex, and young age. The prevalence of ramp lesions was observed to be higher in males (18.6% vs. 12.0%) than in females. The prevalence of ramp rips was found to be substantially higher in patients under 30 than in those over 30.[25,30]

One thing to consider was the interval time since the injury. The knee with an ACL deficiency is where ramp lesions most frequently arise. While ramp lesions are frequently associated with ACL injuries, patients with chronic ACL tears had a higher prevalence of ramp tears (18.8% vs. 12.7%) than patients with acute (less than 6 weeks old) ACL tears.[25] Three months after injury was the earliest noticeable increase in incidence of meniscal tears in an ACL-deficient knee. Therefore, clinicians may find the signs and symptoms long after the history of injury. For this reason, when an ACL tear occurs, the clinician needs to be highly cautious of the possible ramp lesion in the future. Symptoms of a ramp lesion may not present in the acute period, which makes the diagnosis challenging.[30]

Clinical diagnostics for ramp lesions are nonspecific. No one meniscal test is definitive, so it is recommended to use a variety of different tests. The tests have an accuracy rate of 60%–95%, depending on the examiner's clinical background.[30] A meniscal lesion cannot be ruled out by a negative meniscal examination. Clinicians should specifically ask if there is any medial joint line pain, as this could indicate a 'hidden lesion'. Posteromedial joint line soreness and the posteromedial pain with maximal flexion of the knee are commonly observed on physical examination in the posterior horn tear of the medial meniscus.[31]

Provocative maneuvers such as McMurray, Fouche, and Steinmann I signs may also detect the presence of meniscal lesions. The McMurray test on the medial meniscus is performed by bending the knee, internally twisting the tibia to create a varus stress, and bringing the knee to full extension while palpating the joint line. Any pain, tenderness, or palpable click is considered a positive result. Additional examinations include the Fouche sign, which is the reversed McMurray sign with tibial internal rotation, and the Steinmann I sign, which is tenderness changing from anterior to posterior with increased flexion.[30]

Radiological Workup

Radiological diagnosis of ramp lesions is challenging. Ramp tears are difficult to detect with MRI, which is frequently used to assess meniscal injuries. MRI is less specific for medial meniscal tears than for lateral tears, and meniscal lesions are more challenging to identify on MRI when ACL rupture is present. Ramp rips cannot be accurately diagnosed by MRI, most likely due to the near-complete extension of the knee throughout the examination, which decreases meniscocapsular gap.[24,25] Additionally, it can be challenging to differentiate far peripheral vertical longitudinal tears of the posterior horn of the medial meniscus from meniscocapsular separation. It is generally accepted that arthroscopic assessment is required to properly diagnose or rule out a ramp lesion.[20,24,25]

MANAGEMENT

Intervention Approach

No clear consensus exists on the appropriate treatment of meniscal ramp lesions. While there is no disagreement that ramp lesions should be treated in the setting of chronic ACL insufficiency, experts disagree over whether surgical intervention is necessary to address a ramp lesion in the setting of an acute ACL rupture. Particularly in the context of acute ACLR, ramp lesions are thought to be a stable rip pattern situated in a highly vascularized area with a favorable biological environment for healing. Additionally, comparable longitudinal meniscal tear patterns that were left unrepaired at the time of ACLR were reported in earlier investigations, which showed reasonable findings.[32] According to these findings, nonsurgical treatment seems logical. Nonetheless, the best course of action would be to repair the lesion since the ramp lesions' hypermobility of the detached meniscocapsular structure during knee flexion and extension differs from that of other peripheral injuries and prevents spontaneous recovery.[20]

ACL reconstruction may be used to address ramp lesions. A systematic review of seven studies done by Alessio, *et al.*, that evaluate the outcomes of ramp lesion treatment showed that the reconstruction can be accomplished with a quadriceps tendon graft, a patellar bone tendon autograft single-bundle reconstruction, or a four-strand hamstring autograft single-bundle reconstruction. Meniscal repair was the preferred approach of treatment (87,4% - 445 from 509 patients) with only a few patients having abrasion and trephination of the lesion.[33] During the arthroscopic surgery, the posterior compartment may be inspected using an auxiliary posteromedial portal or a trans-notch visualization. A hybrid method was used to restore the meniscus if the rupture had expanded to the midsection.[33]

Rehabilitation

To avoid repair failure, a minimum of two weeks of non-weight bearing or toe-touch weight bearing was recommended. Patients were permitted to bear their entire weight after 4–12 weeks following surgery. To prevent stiffness, immediate postoperative passive joint motions between 0° and 90° were permitted. It is suggested to keep the knee bent at a 90-degree flexion to reduce the likelihood

of neurovascular injury. A complete range of motion was allowed six weeks following surgery. The follow-up time ranged from 6 to 47 months, with a mean of 23.6 months. Lysholm scores, International Knee Documentation Committee (IKDC) scale, or Hospital for Special Surgery (HSS) scores were used to clinically assess residual symptoms. At follow-up, an MRI examination or arthroscopy was considered to assess meniscal and neurovascular healing.[33–35]

Biological Augmentation

Biological enhancement from bone marrow substances released within the joint was thought to be responsible for improved overall results in meniscus tears associated with ACL injury.[36] Following single bundle ACL reconstruction with bone tunnelling and notchplasty, there was a significantly greater local release of vascular endothelial growth factor (VEGF) and its angiogenetic receptor, vascular endothelial growth factor receptor 2 (VEGFR2), than following arthroscopic partial meniscectomy. This suggests that ACL reconstruction with tunnelling has a better vasculogenic effect and may have improved meniscus recovery capacity. As a result, it is reasonable to consider biological augmentation, such as adding platelet-rich plasma (PRP) or creating holes in the notch with a pick to stimulate bone marrow. However, it is unclear whether this step is necessary.[20]

MRI Imaging for Ramp Lesion

Many radiologists concluded that MRI had limited sensitivity (48%) and failed to report ramp lesions found on the scan.[36] Ramp lesions have been observed to be difficult to detect using MRI; a methodical arthroscopic procedure is necessary to fully identify these lesions.[20] In adults with ACL reconstructions, ramp lesions affect 15% to 24% of knees, but around 77% are difficult to diagnose on MRI.[37] Nowadays, arthroscopy is the gold standard for meniscal ramp lesion diagnosis. Meanwhile, MRI is important in evaluating the posteromedial meniscocapsular junction as physical exam findings are nonspecific. It is essential to have an accurate preoperative diagnosis to allow good surgical planning; MRI still has a fundamental role in the management of ramp lesions.[27,38]

Ramp lesions were found in 18 preoperative MRIs out of 68 patients with knee injuries (26.5%).[39] Stranger, *et al*., report that only 68.4% ramp lesions were detected by MRI; type 4 lesions were more likely to be detected than type 3 lesions.[40] Meniscocapsular junction tears (type I) and partial inferior tears (type III) were the most frequently missed lesions on preoperative MRI images among the subtypes of ramp lesions.[26] MRI showed sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of 62.5%, 84.5%, 43.5%, and 92.2%, respectively in detecting a ramp lesion.[18,41] MRI has low sensitivity but has high specificity for diagnosing ramp lesions.[16] Another study showed the positive prediction values of MRI were 40%, and the sensitivity of MRI was 57%.[17]

During the MRI, the knee was fully extended. It has been noted that MRIs performed with the knee in full or almost full extension are more difficult to identify ramp lesions because this position reduces meniscocapsular separation.[42–44] A meta-analysis of nine studies resulted in high pooled specificity (94%), moderate pooled sensitivity (71%), and increased to 84% when a 3.0 T MRI was used with the patient's knee in a neutral position (30^0 flexion). The radiological evidence of musculoskeletal involvement was also considered important in MRI interpretation.[27] A ramp lesion is suspected if there is a thin fluid signal separating the posteromedial capsule and the posterior horn of the medial meniscus or the presence of a posteromedial tibial bone bruise.[16] Hayatama, *et al*., reported the distinctive MRI result of ramp lesions: strong signal irregularity of the capsular edge of the medial meniscus posterior horn on T2-weighted gradient-echo sagittal images.[45]

Repair or Conserve?

Unilateral ACL reconstruction did not lead to a lower functional knee score than non-treatment of stable, unrepaired ramp lesions.[46] Balzas, *et al*., revealed no discernible difference in the results between untreated medial meniscal root lesions and those that underwent ACL reconstruction surgery.[7] Regarding return to sports activity, Dephilippo, *et al*., reported no statistically significant differences between patients undergoing stand-alone ACL replacement and patients undergoing ACL restoration with a meniscal ramp repair.[47] An 82% rate of recovery to the pre-injury level of exercise was reported in a study by Thaunat, *et al*.,.[27] Repairing ramp lesions may not be required while undergoing concurrent ACL reconstruction, but took longer to return to sport at the same activity level than it did for those with isolated ACL reconstruction.[48]

The goal of correcting unstable meniscal ramp lesions was to restore normal knee function.[46] Liu, *et al*., demonstrated no significant difference in ramp lesion healing in terms of repair.[34] Hatayama, *et al*., found that the rate of recovery for ramp lesions was significantly greater in the repaired group compared to the unrepaired group.[49] The biological factor linked to ACL restoration and the anatomic location of the ramp lesion, which is mostly in a vascular region, both promote recovery without medical intervention.[50] Small (less than 10 mm) isolated rips in the red-red zone (a well-vascularized zone) can be stable and allow for conservative treatment.[51]

CONCLUSION

Ramp lesions are meniscus lesions that often go undetected and are frequently missed. They are commonly associated with ACL rupture and are prevalent among athletes, typically during their productive years. Several studies have shown no difference in stability between repaired and unrepaired lesions. The only significant difference was that repaired lesions recovered faster. Consideration for ramp lesion repair depends on the individual, especially those requiring fast recovery, such as athletes and individuals with high levels of physical activity.

REFERENCES

1. Simonetta R, Russo A, Palco M, Costa G, Mariani P. Meniscus tears treatment: the good, the bad and the ugly-patterns classification and practical guide. World J Orthopedic. 2023;14(4):171–85. doi: 10.5312/wjo.v14.i4.171.
2. Marin F, Soto J, Barahona M, Negrin R. Searching for the best treatment for ramp lesions: a systemic review and network meta-analysis. Cureus 2023;15(7):e41651. doi:10.7759/cureus.41651.
3. Thaunat M, Jan N, Fayard JM, Kajetanek C, Murphy CG, Pupim B, et al. Repair of meniscal ramp lesions through a posteromedial portal during anterior cruciate ligament reconstruction: outcome study with a minimum 2-year follow-up. Arthroscopy. 2016;32:2269–77. doi:10.1016/j.arthro.2016.02.026.
4. Li S, Qin Y, Wang H, Qin Z, Jiang L, Zhu S, et al. Repair of ramp lesions of the medial meniscus with ACL reconstruction can better restore knee stability: a cadaveric study. Orthop J Sports Med. 2023;11(4):23259671221140120. doi: 10.1177/23259671221140120.
5. Siboni R, Pioger C, Jacquet C, Mouton C, Seil R. Ramp lesions of the medial meniscus. Curr Rev Musculoskelet Med. 2023;16(5):173–81. doi: 10.1007/s12178-023-09834-2.
6. Kambhampati SBS, Chittoor SP, Akella SR. Bony injury associated with ramp lesion and a double meniscal injury - a hidden terrible triad of the posteromedial knee. J Clin Orthop Trauma. 2021;16:264–8. doi: 10.1016/j.jcot.2021.02.020.
7. Balazs GC, Greditzer HG 4th, Wang D, Marom N, Potter HG, Marx RG, et al. Ramp lesions of the medial meniscus in patients undergoing primary and revision ACL reconstruction: prevalence and risk factors. Orthop J Sports Med. 2019;7(5):2325967119843509. doi: 10.1177/2325967119843509.
8. Gupta S, Hishikar P, Ray B. Arthroscopic ramp repair: "no-implant, pass, park, and tie technique" using knee scorpion. Arthrosc Tech. 2023;12(5):e763–70. doi: 10.1016/j.eats.2023.02.005.
9. Cristiani R, van de Bunt F, Kvist J, Stalman A. High prevalence of meniscal ramp lesions in anterior cruciate ligament injuries. Knee Surg Sports Traumatol Arthrosc. 2023;31(1):316–24. doi: 10.1007/s00167-022-07135-8.
10. Kaiser JT, Meeker ZD, Horner NS, Sivasundaram L, Wagner KR, Mazra AF, et al. Meniscal ramp lesions - skillful neglect or routine repair? J Orthop. 2022;32:31–5. doi: 10.1016/j.jor.2022.05.001.
11. Fox AJ, Bedi A, Rodeo SA. The basic science of human knee menisci: structure, composition, and function. Sports Health 2012;4(4):340–51. doi: 10.1177/1941738111429419.
12. Fox AJ, Wanivenhaus F, Burge AJ, Warren RF, Rodeo SA. The human meniscus: a review of anatomy, function, injury, and advances in treatment. Clin Anat. 2015;28(2):269–87. doi: 10.1002/ca.22456.
13. Taneja AK, Miranda FC, Rosemberg LA, Santos DCB. Meniscal ramp lesions: an illustrated review. Insights Imaging 2021;12(1):134. doi: 10.1186/s13244-021-01080-9.
14. Mahmood A, Krishna S, Garika S S, Mittal R, Digge VK, Gamanagatti S. Ramp lesion in chronic anterior cruciate ligamen injuries. Cureus 2022;14(8):e28450. doi: 10.7759/cureus.28450 .
15. Qalib YO, Tang Y, Wang D, Xing B, Xu X, Lu H. Ramp lesion of the medial meniscus. EFFORT Open Rev. 2021;6(5):372–9. doi: 10.1302/2058-5241.6.200126.
16. D'Ambrosi R, Di Maria F, Ursino C, Ursino N, Di Feo F, Formica M, et al. Magnetic resonance imaging shows low sensitivity but good specificity in detecting ramp lesions in children and adolescents with ACL injury: a systematic review. J ISAKOS. 2024;9(3):371–7. doi: 10.1016/j.jisako.2023.12.005.
17. Bernardini I, N'Dele D, Faruch Bilfeld M, Thevenin-Lemoine C, Vial J, Cavaignac E, et al. Prevalence and detection of meniscal ramp lesions in pediatric anterior cruciate ligament-deficient knees. Am J Sports Med. 2021;49(7):1822–6. doi: 10.1177/03635465211010123.
18. Kim SH, Seo HJ, Seo DW, Kim KI, Lee SH. Analysis of risk factors for ramp lesions associated with anterior cruciate ligament injury. Am J Sports Med. 2020;48(7):1673–81. doi: 10.1177/0363546520918207.
19. Srimongkolpitak S, Chernchujit B. Current concepts on meniscal repairs. J Clin Orthop Trauma. 2022;27:101810. doi: 10.1016/j.jcot.2022.101810.
20. Chahla J, Dean CS, Moatshe G, Mitchell JJ, Cram TR, Yacuzzi C, et al. Meniscal ramp lesions: anatomy, incidence, diagnosis, and treatment. Orthop J Sports Med. 2016;4(7):2325967116657815. doi: 10.1177/2325967116657815.

21. Asai K, Nakase J, Yoshimizu R, Kimura M, Tsuchiya H. Excessive anterior tibial translation in the contralateral uninjured limb is significantly associated with ramp lesion in anterior cruciate ligament injury. J Exp Orthop. 2021;8(1):54. doi: 10.1186/s40634-021-00372-9.

22. Abreu FG, Canuto SMG, Canuto MMG, Chagas EF, Zutin TLM, Padua VBC. Incidence of meniscal ramp lesion in anterior cruciate ligament reconstructions. Rev Bras Ortop (Sao Paulo). 2022;57(3):422–8. doi: 10.1155/s-0041-1735942.

23. Espejo-Reina A, Sevillano-Perez E, Espejo-Reina MJ, Lombardo-Torre M, Perez-Blanca A, Espejo-Baena A. The proportion of meniscus tears considered repairable, and thus repaired, increased during a single surgeon's practice of 20 years. Arthrosc Sports Med Rehabil. 2023;5(5):100778. doi: 10.1016/j.asmr.2023.100778.

24. Bollen SR. Posteromedial meniscocapsular injury associated with rupture of the anterior cruciate ligament: a previously unrecognised associations. J bone Joint Surg Br. 2010;92:222–3. doi: 10.1302/0301-620X.92B2.22974.

25. Liu X, Feng H, Zhang H, Hong L, Wang XS, Zhang J. Arthroscopic prevalence of ramp lesion in 868 patients with anterior cruciate ligament injury. Am J Sports Med. 2011;39(4):832–7. doi: 10.1177/0363546510388933.

26. Thaunat M, Ingale P, Penet A, Kacem S, Haidar I, Bauwens PH, et al. Ramp lesion subtypes: prevalence, imaging, and arthroscopic findings in 2156 anterior cruciate ligament reconstructions. Am J Sports Med. 2021;49(7):1813–21. doi: 10.1177/03635465211006103.

27. Escoda Menendez S, Garcia Gonzalez P, Meana Morís AR, Del Valle Soto M, Maestro Fernandez A. Meniscal ramp lesions: what the radiologist needs to know. Acad Radiol. 2022;29(4):619–26. doi: 10.1016/j/acra.2021/02/005.

28. Bae BS, Yoo S, Lee SH. Ramp lesion in anterior cruciate ligament injury: a review of the anatomy, biomechanics, epidemiology, and diagnosis. Knee Surg Relat Res. 2023;35(1):23. doi: 10.1186/s43019-023-00197-z.

29. Pires D, Monteiro L, Rocha de Faria JL, Albuquerque RSPE, Astur D, Padua VBC, et al. Diagnosis by manual maneuver of medial meniscus ramp lesions. Arthrosc Tech. 2023;12(6):e959–64. doi: 10.1016/j.eats.2023.02.033.

30. Young R, Devitt BM, Whitehead T. Menical ramp lesion: diagnosis and treatment strategies. In: LaPrade R, Arendt EA, Getgood A, Faucett S, editors. A comprehensive review of their anatomy, biomechanical function and surgical treatment.1st ed. Heidelberg, Berlin: Springer; 2018. p.65–73.

31. Maak TG, Fabricant PD, Wickiewicz TL. Indications for meniscus repair. Clin Sports Med. 2012;31(1):1–14 doi: 10.1016/j.csm.2011.08.012.

32. Duchman KR, Westermann RW, Spindler KP, Reinke EK, Huston LJ, Amendola A, et al. The fate of meniscus tears left in situ at the time of anterior cruciate ligament reconstruction: a 6-year follow-up study from the MOON cohort. Am J Sports Med. 2015;43:2688–95. doi: 10.1177/0363546515604622.

33. Alessio-Mazzola M, Lovisolo S, Capello AG, Zanirato A, Chiarlone F, Formica M, et al. Management of ramp lesions of the knee: a systematic review of the literature. Musculoskelet Surg. 2020;104(2):125–33. doi: 10.1007/s12306-019-00624-z.

34. Liu X, Zhang H, Feng H, Hong L, Wang XS, Song GY . Is it necessary to repair stable ramp lesions of the medial meniscus during anterior cruciate ligament reconstruction? a prospective randomized controlled trial. Am J Sports Med. 2017;45:1004–11 doi: 10.1177/0363546516682493.

35. Yang J, Guan K, Wang JZ. Clinical study on the arthroscopic refreshing treatment of anterior cruciate ligament injury combined with stable medial meniscus ramp injury. Musculoskelet Neuronal Interact. 2017;17(2):108–13. PMID: 28574418.

36. Hutchinson ID, Moran CJ, Potter HG, Warren RF, Rodeo SA. Restoration of the meniscus: form and function. Am J Sports Med. 2014;42:987–98 doi: 10.1177/0363546513498503.

37. Kawada K, Furumatsu T, Tamura M, Xue H, Higashihara N, Kintaka K, et al. Effectivity of the outside-in pie-crusting technique and an all-inside meniscal repair device in the repair of ramp lesions. Arthrosc Tech. 2023;12(2):e273–8. doi: 10.1016/j.eats.2022.11.002.

38. Pfeiffer TP, Murphy CI, Arner JW, Musahl V. Identification and treatment of RAMP lesions in anterior cruciate ligament-injury knees. Ann Joint. 2017;2:17. doi: 10.21037/aoj.2017.05.06.

39. Moran J, Jimenez AE, Katz LD, Wang A, McLaughlin WM, Gillinov SM, et al. Examining preoperative MRI for medial meniscal ramp lesions in patients surgically treated for acute grade 3 combined posterolateral corner knee injury. Orthop J Sports Med. 2023;11(2):23259671221144767. doi: 10.1177/23259671221144767.

40. Stranger N, Kaulfersch C, Mattiassich G, Mandl J, Hausbrandt PA, Szolar D, et al. Frequency of anterolateral ligament tears and ramp lesions in patients with anterior cruciate ligament tears and associated injuries indicative for these lesions-a retrospective MRI analysis. Eur Radiol. 2023;33(7):4833–41. doi: 10.1007/s00330-023-09444-z.

41. Willinger L, Balendra G, Pai V, Lee J, Mitchell A, Jones M, et al. Medial meniscal ramp lesions in ACL-injured elite athletes are strongly associated with medial collateral ligament injuries and medial tibial bone bruising on MRI. Knee Surg Sports Traumatol Arthrosc. 2022;30(5):1502–10. doi: 10.1007/s00167-021-06671-z.

42. Zappia M, Sconfienza LM, Guarino S, Mariani MT. Meniscal ramp lesion: diagnostic performance of MRI with arthroscopy as reference standard. La radiologia Medica. 2021;126:1106–16. doi: 10.1007/s11547-021-01375-3.

43. Alomar AZ. Novel type of medial meniscus ramp lesion: a case report and surgical technique. J Surg Case Rep. 2021;2021(12):rjab538. doi: 10.1093/jscr/rjab538.

44. Moreira J, Almeida M, Lunet N, Gutierres M. Ramp lesions: a systematic review of MRI diagnostic accuracy and treatment efficacy. J Exp Orthop. 2020;7(1):71. doi: 10.1186/s40634-020-00287-x.

45. Hatayama K et al. Ramp lesion associated with anterior cruciate ligament rupture. 2013. Available at https://www.isakos.com/meetings/2013congress/onsite/AbstractView?EventID=7751. Accessed October 1, 2024 .

46. Albayrak K, Buyukkuscu MO, Kurk MB, Kaya O, Kulduk A, Misir A. Leaving the stable ramp lesion unrepaired does not negatively affect clinical and functional outcomes as well as return to sports rates after ACL reconstruction. Knee Surg Sports Traumatol Arthrosc. 2021;29:3773–81. doi: 10.1007/s00167-020-06402-w.

47. DePhillipo NN, Dornan GJ, Dekker TJ, Aman ZS, Engebretsen L, LaPrade RF. Clinical characteristics and outcomes after primary ACL reconstruction and meniscus ramp repair. Orthop J Sports Med. 2020;8(4):2325967120912427. doi: 10.1177/2325967120912427.

48. D'Ambrosi R, Meena A, Raj A, Giorgino R, Ursino N, Mangiavini L, et al. Good results after treatment of RAMP lesions in association with ACL reconstruction: a systematic review. Knee Surg Sports Traumatol Arthrosc. 202331(1):358–71. doi: 10.1007/s00167-022-07067-3.

49. Hatayama K, Terauchi M, Saito K, Takase R, Higuchi H. Healing status of meniscal ramp lesion affects anterior knee stability after ACL reconstruction. Orthop J Sports. 2020;8:2325967120917674. doi: 10.1177/2323967120917674.

50. Mostafa Zaky Abdelrazek BH, Waly MR, Abdel Aziz MA, Abdel Aziz A. Different techniques for the management of meniscal ramp lesions using standard anterior portals. Arthrosc Tech. 2019;18;9(1):e39–e44. doi: 10.1016/j.eats.2019.08.020.

51. Sonnery-Cottet B, Serra Cruz R, Vieira TD, Goes RA, Saithna A. Ramp lesions: an unrecognized posteromedial instability? Clin Sports Med. 2020;39(1):69–81. doi: 10.1016/j.csm.2019.08.010.