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MEDIAL MENISCUS RAMP LESIONS: A REVIEW OF TREATMENT METHODS AND CLINICAL OUTCOMES

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ABSTRACT

Introduction: Ramp lesions of the medial meniscus (tears at the meniscocapsular junction of the posterior horn) have historically been underdiagnosed but are now recognized as a common co-injury in anterior cruciate ligament (ACL) tears. Their prevalence, impact on knee biomechanics, and clinical outcomes following different treatment strategies remain subjects of increasing interest and debate.

Objective: This review aims to summarize current anatomical knowledge, diagnostic approaches, classification systems, and treatment options for ramp lesions, with a focus on their relevance in arthroscopic surgery and rehabilitation outcomes.

Results: MRI remains a widely used but imperfect diagnostic tool, with sensitivity ranging from 65% to 71%. Arthroscopic evaluation, particularly via posteromedial or trans-notch portals, is considered the gold standard. Treatment strategies depend on lesion stability: stable ramp lesions may be observed or treated with biological augmentation (e.g., abrasion or trephination), while unstable lesions typically require repair. Surgical techniques include all-inside sutures (anterior or posteromedial), inside-out methods, and hybrid approaches. Clinical outcomes following surgical repair are generally favorable, with improved IKDC and Lysholm scores. However, high-level evidence comparing treatment strategies remains limited.

Conclusions: Unstable ramp lesions should be surgically addressed during ACL reconstruction to optimize graft protection and joint biomechanics. The treatment of stable lesions remains debated, and current evidence does not clearly favor either conservative or surgical management. High-quality, prospective studies are needed to standardize diagnostic criteria and define optimal treatment algorithms based on lesion stability and patient-specific factors.

Keywords: medial meniscus, ramp lesion, ACL reconstruction, meniscal repair, conservative treatment, knee instability, clinical outcomes

1. INTRODUCTION

1.1 ANATOMY OF THE POSTERIOR HORN OF THE MEDIAL MENISCUS

The medial meniscus is a crescent-shaped fibrocartilaginous structure situated between the medial condyle of the femur and the medial tibial plateau, contributing significantly to load transmission, joint stability, shock absorption, and proprioception within the knee joint [1]. Anatomically, the medial meniscus is less mobile than its lateral counterpart due to its firm attachment to the deep fibers of the medial collateral ligament [1].

The posterior horn of the medial meniscus plays a critical role in knee biomechanics, anchoring firmly into the tibial plateau and providing stability against anterior tibial translation [1]. Its peripheral attachments, specifically the meniscocapsular and meniscotibial junctions, are of particular relevance. Histological analysis reveals that the meniscocapsular attachment is denser than the meniscotibial attachment, consisting of loosely organized collagen fibers interspersed with capillaries and a low density of fibroblasts [2]. Importantly, no distinct meniscotibial ligament has been consistently identified; rather, the structure appears as a continuation of the meniscocapsular tissue [2].

The vascularization of the posterior horn is provided predominantly by the medial, lateral, and middle genicular arteries, supplying primarily the peripheral "red-red" zone, while the inner "white-white" zone relies on diffusion from synovial fluid [1]. Due to this limited vascularization, the healing capacity of injuries within the inner meniscus is significantly impaired.

The innervation of the medial meniscus, including its posterior horn, is mediated by the posterior tibial, obturator, and femoral nerves. Mechanoreceptors located in this region, particularly Ruffini endings, Pacinian corpuscles, and Golgi tendon organ receptors, contribute to joint proprioception and the regulation of neuromuscular responses to mechanical stress [1].

Anatomically, the posterior horn can be divided into specific zones, with "Zone 4" according to Smigielski et al., encompassing the area where ramp lesions are most frequently located [2]. These lesions involve the disruption of the meniscocapsular or meniscotibial attachments and are typically associated with anterior cruciate ligament (ACL) injuries [2].

The histological features of the posterior horn's attachments suggest a structure designed to withstand complex mechanical loads rather than serve a purely ligamentous function. The presence of vascular structures within these attachments also supports the potential for spontaneous healing under favorable biomechanical conditions [2].

1.2 RAMP LESION

Ramp lesions of the medial meniscus occur when the meniscocapsular junction at the level of the posterior horn is injured, as first described by Strobel M in 1988 [3]. These injuries involve the peripheral attachment of the posterior horn of the medial meniscus and are frequently associated with anterior cruciate ligament (ACL) ruptures [4,5]. Due to their peripheral and hidden location, ramp lesions are often difficult to detect during standard anterior arthroscopic exploration [4,6].

A pivotal moment in the understanding of ramp lesions was the introduction of a classification by Thaunat et al. [8]. They proposed a five-type classification based on both tear morphology and the extent of associated meniscotibial ligament disruption:

- Type 1: Peripheral meniscocapsular tears, very stable.
- Type 2: Partial-thickness superior tears.
- Type 3: Partial-thickness inferior tears ("hidden lesions"), often challenging to visualize.
- Type 4: Full-thickness vertical longitudinal tears.
- Type 5: Complex or double lesions involving both superior and inferior detachments.

From a clinical perspective, ramp lesions are also frequently classified in a simpler binary system into stable and unstable lesions, which has practical implications for their management [5,9,10].

- Stable lesions: Non-displaceable with probing; often managed conservatively or by biological stimulation (e.g., refreshing).
- Unstable lesions: Displaceable upon probing; typically require arthroscopic repair to restore knee

stability.

Table 1. Classification and Surgical Implications

Author (Year)	Classification Type	Description	Clinical Relevance
Thaunat et al. (2016) [8]	Arthroscopic-based	5 types based on arthroscopic appearance and lesion depth	Guides surgical approach depending on tear location and depth
Greif et al. (2020)[11]	MRI-based	Differentiates lesions by signal intensity and disruption on MRI images	Assists in preoperative planning
Seil et al. (2017) [12]	Anatomical-surgical hybrid	Considers location, morphology, and associated ACL injuries	Integrates anatomical context with surgical strategy

1.3 BIOMECHANICAL AND CLINICAL SIGNIFICANCE

1.3.1 Biomechanical Significance of Ramp Lesions

Ramp lesions of the medial meniscus, particularly those involving the posterior horn at the meniscocapsular or meniscotibial junctions, have substantial implications for knee biomechanics. These lesions compromise the meniscus' ability to resist anterior tibial translation and internal tibial rotation, especially under conditions where the anterior cruciate ligament (ACL) is deficient or recently reconstructed [4,6,10].

Biomechanical studies have demonstrated that the posterior horn of the medial meniscus functions as a secondary stabilizer to the ACL, particularly during activities involving knee flexion and rotational loads. When ramp lesions are present and left untreated, this stabilizing effect is diminished, potentially leading to persistent instability even after technically successful ACL reconstruction [2,4,6].

Notably, Papageorgiou et al. have demonstrated in cadaveric models that injury to the medial meniscus can increase the load on the ACL graft by as much as 33% to 50%, emphasizing the importance of an intact meniscocapsular complex for graft longevity[13]. These findings underscore the biomechanical interplay between the posterior horn of the medial meniscus and ACL grafts, particularly in the early postoperative period, when graft integration is still progressing [6].

Moreover, the undetected presence of a ramp lesion may result in abnormal joint kinematics, increased anterior tibial translation, and higher forces transmitted through the ACL graft, thereby predisposing the reconstructed ligament to failure [5,6,9]. These lesions are also associated with altered patterns of load transmission and contact pressure across the tibiofemoral joint, which could accelerate degenerative changes and cartilage damage if not adequately addressed [5,7].

It is also noteworthy that stable ramp lesions (those not showing displacement upon probing) may not have the same biomechanical consequences as unstable lesions. Some studies suggest that stable lesions might heal spontaneously under the biological environment provided by ACL reconstruction, particularly due to intra-articular hemarthrosis, which promotes healing [6,7,9]. However, this remains a topic of ongoing debate.

In light of these findings, the biomechanical integrity of the posteromedial meniscocapsular junction should be considered a critical component of knee joint stability, particularly in the setting of ACL injuries. The decision whether to surgically address ramp lesions depends heavily on their classification and intraoperative assessment of stability.

1.3.2 Clinical significance and association with ACL injuries

Surgical repair of unstable ramp lesions at the time of ACL reconstruction has been shown to restore joint stability more effectively than ACL reconstruction alone [7,9].

Therefore, understanding and addressing ramp lesions during ACL surgery is crucial for restoring joint stability, minimizing postoperative complications, and optimizing functional recovery. Their clinical importance continues to grow as diagnostic techniques and surgical awareness improve.

1.4 JUSTIFICATION AND RELEVANCE OF THE STUDY

Ramp lesions of the medial meniscus, although once considered rare or overlooked, have gained increasing attention over the past decade due to advancements in arthroscopic techniques and growing clinical awareness. Earlier studies estimated their prevalence among ACL-injured patients at approximately 9%, but with the use of posteromedial and trans-notch arthroscopic approaches, current data suggest that ramp lesions may occur in up to 42% of ACL tears [4,6,9]. This significant rise in detection highlights both a diagnostic challenge and a clinical imperative to better understand these injuries. Despite the increased recognition of ramp lesions, consensus regarding optimal management remains elusive. While many authors advocate surgical repair for unstable lesions, especially in the setting of ACL reconstruction, others have reported comparable clinical outcomes with conservative treatment or biological augmentation alone for stable lesions [5,7,9,15]. These divergent findings have fueled ongoing debate within the orthopedic community regarding which lesions require operative intervention, and what criteria should guide such decisions. The therapeutic controversy is further compounded by the heterogeneity in lesion classification, surgical techniques, and outcome assessment. Various classification systems (such as those proposed by Thaunat et al. and Greif et al.[8]) seek to differentiate ramp lesion subtypes based on anatomical location, tear morphology, and biomechanical behavior. However, uniform clinical guidelines are still lacking, and the absence of high-quality randomized trials limits the ability to establish definitive treatment algorithms [4,6,10]. In this context, a critical need emerges to synthesize and compare existing evidence on the outcomes of surgical and nonsurgical interventions for ramp lesions, particularly in relation to lesion stability and concurrent ACL reconstruction. Clarifying these issues holds practical significance for surgeons in tailoring management strategies that preserve joint stability and reduce the risk of graft failure.

Therefore, this review aims to synthesize current knowledge on treatment strategies for medial meniscus ramp lesions, compare clinical outcomes across surgical and conservative approaches, and identify gaps that warrant further research to guide evidence-based decision-making.

1.5 OBJECTIVE

The aim of this narrative review is to provide a comprehensive overview of ramp lesions of the medial meniscus, focusing on anatomical features, diagnostic challenges, and current management strategies. Particular emphasis is placed on synthesizing existing classification systems and evaluating the diagnostic accuracy of imaging and arthroscopic techniques. By summarizing and comparing current diagnostic modalities and surgical approaches, this review aims to identify knowledge gaps and suggest directions for standardization and improved clinical outcomes.

The practical novelty of this review lies in its attempt to integrate recent findings into a clinically oriented framework that can support decision-making in orthopedic and sports medicine practice.

2. MATERIALS, METHODS AND PICO FRAMEWORK

2.1 SEARCH STRATEGY

A comprehensive literature search was conducted in the PubMed and Embase databases using the following Boolean query: (meniscal ramp lesion OR ramp lesion OR posteromedial meniscal tear) AND (arthroscopic repair OR surgical repair OR meniscal suture OR surgical treatment OR conservative treatment OR nonoperative management OR physical therapy OR rehabilitation) AND (clinical outcomes OR functional outcomes OR return to sport OR patient-reported outcomes OR KOOS OR IKDC) AND (anterior cruciate ligament OR ACL injury OR ACL reconstruction).

The search was limited to articles in English with full-text availability, published between 2010 and 2024. The initial search yielded 55 results in PubMed and 51 in Embase. After removing duplicates, 79 unique articles remained for screening. Following a review of titles and abstracts, 46 studies were selected for full-text analysis. After applying eligibility criteria, 29 studies were ultimately included in this review.

2.2 INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria comprised original articles that addressed any of the following:

- Clinical outcomes of surgical or nonoperative treatment of medial meniscus ramp lesions
- Description or evaluation of surgical techniques or diagnostic methods specific to ramp lesions
- Studies offering biomechanical or radiologic insights relevant to diagnosis, classification, or treatment rationale of ramp lesions

Although the majority of included studies presented patient-reported outcomes or surgical results, some were incorporated due to their relevance in improving understanding of diagnostic approaches, surgical

access routes, or tissue healing behaviour. One radiologic study was also included due to its significant contribution to diagnostic classification and preoperative evaluation.

Exclusion criteria included:

- Non-English publications
- Lack of access to full text
- Studies focused solely on meniscal pathology unrelated to ramp lesions

2.3 PICO FRAMEWORK

This review was structured using the PICO framework to ensure a systematic and clinically relevant synthesis of findings:

Population (P): Patients diagnosed with ramp lesions of the medial meniscus, typically in association with anterior cruciate ligament (ACL) injury or reconstruction

Intervention (I): Arthroscopic repair techniques (e.g., all-inside, inside-out sutures, or hybrid methods), as well as biological augmentation strategies (e.g., abrasion or trephination)

Comparison (C): Conservative or nonoperative treatment, including observation or rehabilitation protocols

Outcomes (O): Functional recovery, knee stability, return to sport, complication and reoperation rates

3. TREATMENT METHODS FOR RAMP LESIONS

3.1 CONSERVATIVE TREATMENT METHODS

Summarising, although nonoperative strategies (particularly biological treatment) appear viable for stable ramp lesions, a lack of high-quality, long-term studies limits definitive guidance. Most authors advocate for individualized decision-making, with conservative management reserved for lesions deemed stable upon probing, asymptomatic in presentation, and occurring in patients with low functional demands or contraindications to extended surgery [7,18].

3.2 SURGICAL MANAGEMENT OF RAMP LESIONS

The surgical treatment of ramp lesions of the medial meniscus encompasses several arthroscopic techniques that vary in terms of portal access, instrumentation, and suture configuration. The choice of surgical strategy is typically guided by lesion stability, anatomical accessibility, surgeon preference, and associated anterior cruciate ligament reconstruction (ACLR).

All-inside repair is the most commonly employed technique. It involves the use of preloaded suture devices that allow for the fixation of the meniscus without the need for accessory incisions. These devices are typically introduced via the anteromedial portal under visualization through a trans-notch view. Sutures are deployed through the meniscal tissue and surrounding capsule, often in the form of pre-tied self-sliding knots, allowing for secure approximation of the lesion margins [5]. This method is minimally invasive and time-efficient, but may be limited in addressing deeper meniscotibial tears, particularly when performed exclusively from anterior portals [9].

Posteromedial portal repairs, especially with the use of a curved hook suture device, offer direct access to the posterior horn and meniscocapsular junction. This method typically requires creation of a working portal posterior and proximal to the medial femoral condyle, enabling more controlled passage of sutures and often superior visualization of the lesion margins. Sutures are advanced every 5 mm along the tear, typically using strong absorbable monofilament materials such as PDS 1 [5].

Inside-out repair techniques involve passing needles loaded with sutures through the meniscus and out through a small posteromedial skin incision. This approach provides flexibility in suture placement and allows for vertical or horizontal mattress configurations depending on the tear morphology. Although this method is technically more demanding and time-consuming, it has been associated with lower rates of secondary meniscectomy compared to all-inside methods, especially in the context of unstable ramp lesions [9].

Trans-septal portal techniques utilize a posterolateral viewing portal in conjunction with a posteromedial working portal. This dual-access method allows for enhanced visualization of the posteromedial compartment and facilitates suture placement in anatomically challenging ramp tears. Though technically complex, it may be advantageous in cases where direct visualization or instrumentation through traditional portals is limited [21].

Hybrid techniques combining inside-out and all-inside methods, or integrating pie-crusting of the medial

collateral ligament to improve joint space visualization, have also been described in the literature. These approaches aim to combine the benefits of different techniques while mitigating their individual limitations [7].

Across all approaches, a consistent emphasis is placed on probing and confirming lesion instability before deciding on surgical repair. While definitive criteria for repair indication are not universally agreed upon, most authors suggest repairing lesions that demonstrate displacement or gapping upon probing, particularly during concomitant ACLR. Suturing techniques are intended to restore the integrity of the meniscocapsular and meniscotibial attachments and thereby reduce anteroposterior and rotational laxity of the knee [5,9].

3.3 TECHNIQUES SELECTION CRITERIA

Despite the growing body of literature surrounding ramp lesion management, no universally accepted treatment algorithm currently exists. The heterogeneity of tear morphology, diagnostic protocols, and surgical approaches contributes to the absence of clear guidelines, leaving clinical decision-making largely dependent on intraoperative findings and surgeon experience [4,6,7].

One of the most consistent observations across studies is the importance of timing. Early identification and treatment of ramp lesions, particularly in conjunction with anterior cruciate ligament reconstruction (ACLR), are associated with superior healing rates and improved knee stability. Delayed repair may lead to progressive meniscal degeneration, capsular retraction, and increased rotational laxity, potentially compromising the success of ACL grafts [6,9,22]. Several authors advocate for systematic inspection of the posteromedial compartment during ACLR to ensure prompt detection and, where appropriate, repair of ramp lesions [5,9].

The stability of the lesion remains a cornerstone in determining treatment strategy. Stable ramp lesions (typically defined as partial-thickness tears that do not displace on probing) may be managed conservatively. Techniques such as biological augmentation (e.g., trephination, abrasion) or even observation have yielded satisfactory outcomes in select patient populations [15,16,18]. However, some reports suggest that even stable lesions may contribute to subtle instability or progressive degeneration if left untreated, especially in high-demand athletes or in the setting of delayed ACLR [19,23].

Conversely, unstable ramp lesions, characterized by displacement, gapping, or abnormal mobility of the posterior horn during probing or dynamic arthroscopic assessment, are widely considered surgical candidates. Repair is typically recommended to restore meniscocapsular integrity, minimize graft overload, and preserve long-term joint stability [5,9,22]. All-inside suturing via posteromedial portals or inside-out repair techniques are the most frequently employed options for these lesions, depending on accessibility and surgeon preference [7,21,24].

Ultimately, the choice of technique should be tailored to lesion characteristics (location, size, and mobility), concomitant procedures (e.g., ACLR), patient activity level, and available instrumentation. While the development of high-level evidence and standardized classification systems is still ongoing, current best practice favors a lesion-specific approach grounded in thorough intraoperative evaluation and awareness of biomechanical consequences.

4. FINDINGS FROM THE LITERATURE REVIEW

4.1 DIAGNOSTIC METHODS AND ACCURACY

The diagnosis of medial meniscus ramp lesions presents a significant challenge in clinical practice, particularly due to their posterior localization and variable visibility on imaging. Although magnetic resonance imaging (MRI) is a standard modality for meniscal evaluation, its diagnostic accuracy for ramp lesions remains suboptimal compared to other types of meniscal tears [6,7,25].

A meta-analysis by Koo et al. reported a sensitivity of 71% and specificity of 94% for detecting ramp lesions with MRI [26], although these values varied significantly depending on the MRI settings and technique used [7]. Notably, performing the scan with the knee in approximately 30° of flexion, using high-field magnets (e.g., 3.0T), and interpretation by musculoskeletal radiologists were associated with improved detection rates, increasing sensitivity up to 84% [7]. Common MRI indicators of ramp lesions include focal separation at the meniscocapsular junction, high signal fluid interposition, and edema of the posteromedial tibial plateau [6,7].

Despite these improvements, MRI can still miss a significant proportion of ramp lesions- especially "hidden" lesions (e.g., type III according to Thaunat's classification), which are often not visible in full knee extension [6,7]. Therefore, arthroscopy remains the gold standard for diagnosis [6,7,25].

Arthroscopic evaluation begins with standard anterior portals. When a ramp lesion is suspected, a transnotch view can be established to visualize the posteromedial compartment. If needed, a spinal needle

is used to confirm lesion presence, followed by the creation of a posteromedial portal, which allows for direct probing and treatment [7]. The use of a 70° arthroscope and accessory posteromedial or transseptal portals further enhances visualization and diagnostic yield [6].

Studies have shown that over 40% of ramp lesions may be missed without a systematic arthroscopic approach that includes transnotch or posteromedial viewing [6]. Therefore, for patients undergoing ACL reconstruction, it is recommended to routinely inspect the posteromedial meniscocapsular region especially when preoperative MRI findings are inconclusive but clinical suspicion remains high.

4.2 OUTCOMES OF CONSERVATIVE MANAGEMENT

Numerous studies have reported that untreated stable ramp lesions can heal spontaneously, especially when accompanied by anatomical ACL reconstruction. Balazs et al. observed no significant differences in postoperative outcomes (including IKDC and Lysholm scores, knee stability tests, and reoperation rates)between patients with stable untreated ramp lesions and those without any ramp lesions [16,27]. Furthermore, a delay in return to sport was minimal or clinically irrelevant in most cases [19].

Biological treatment methods, such as abrasion, edge curettage, and trephination, have been proposed to enhance the intrinsic healing capacity of stable ramp lesions without suturing. These minimally invasive techniques aim to stimulate vascular ingrowth and fibrocartilaginous healing by disrupting the synovial lining around the tear margins [18,28]. Liu et al. and Yang et al. reported that outcomes of patients treated with abrasion or trephination were comparable to those who underwent all-inside suture repair in terms of Lysholm and IKDC scores, range of motion, and return to activity [27–29].

However, the success of conservative management may be influenced by multiple factors, including the chronicity of the lesion, concomitant ACL injury status, and individual biological healing potential. Some studies emphasize that the presence of meniscal extrusion, a steep tibial slope, or high BMI may negatively affect healing capacity and clinical outcome [14,15].

4.3 OUTCOMES OF SURGICAL TREATMENT

Surgical intervention for ramp lesions is widely recommended for unstable tears or in cases where lesion stability cannot be reliably confirmed during arthroscopy. These lesions, often identified using posteromedial or transnotch portals, tend to gap upon probing and have a lower chance of spontaneous healing, especially in the absence of concurrent ACL reconstruction [6,9,23]. Several surgical techniques have been employed to address ramp lesions, each with varying clinical outcomes:

All-inside repair using devices such as FasT-Fix or Mitek through the anterior portal has been a popular choice for easily accessible ramp lesions. While technically straightforward and less invasive, this approach has shown higher failure or reoperation rates compared to more direct repair strategies, primarily due to limited access to the meniscotibial junction [6,24].

All-inside repair via a posteromedial portal, often utilizing a suture hook device, offers better visualization and control during repair, especially for deep and posteriorly located ramp lesions. Studies indicate this technique results in superior healing rates and fewer postoperative complications, including a lower risk of secondary meniscectomy [9,24].

Inside-out suturing (considered by many as the gold standard) allows precise placement of sutures along both the meniscocapsular and meniscotibial junctions. While more technically demanding and associated with a small risk of neurovascular injury, outcomes have consistently demonstrated high success rates and restored knee stability [9,20].

Hybrid techniques combining all-inside and inside-out approaches, or employing trans-septal access, are used in complex cases. These allow for full visualization and enhanced access to both anterior and posterior aspects of the lesion, particularly in chronic or multilayered tears [6,24].

Clinical outcome scores post-repair are encouraging across all techniques. Lysholm scores often improve from preoperative values in the 50s–60s to postoperative values in the high 80s or 90s, and similar improvements are seen in IKDC scores [20,22,24]. The majority of patients return to sports within 7–10 months after surgery, although outcomes can vary based on age, chronicity of injury, and rehabilitation adherence [19,22].

In conclusion, surgical treatment of ramp lesions, especially when performed early and using appropriate portal access, yields excellent outcomes in terms of healing, stability, and return to activity. However, no universal consensus exists regarding the superiority of one repair technique over another, and treatment should be tailored to lesion type, chronicity, and intraoperative findings.

4.4 IMPACT OF UNTREATED RAMP LESIONS ON ACLR OUTCOMES

Untreated ramp lesions, particularly those that are unstable or go unrecognized during anterior cruciate

ligament reconstruction (ACLR), may have a significant negative impact on postoperative outcomes. These lesions disrupt the continuity between the medial meniscus and the posteromedial capsule or tibial plateau, compromising the stabilizing function of the posterior horn and thereby contributing to residual knee instability [9,22,23].

Multiple biomechanical and clinical studies have shown that leaving a ramp lesion untreated can result in increased anterior tibial translation and rotational laxity, even after anatomically successful ACLR [6,15,22]. This residual laxity is attributed to the failure of the posteromedial structures to act as secondary stabilizers, placing greater stress on the reconstructed ACL graft.

The long-term implications of such untreated lesions are also concerning. Several authors report higher rates of ACL graft re-rupture in patients with ramp lesions that were either missed or intentionally left untreated due to their perceived stability [20,23,30]. For instance, patients with non-repaired ramp lesions demonstrated greater side-to-side laxity and reduced subjective outcomes, including lower IKDC and Lysholm scores over follow-up periods extending beyond two years [19,30].

Moreover, healing rates of ramp lesions left in situ have been shown to be inferior to those of surgically treated lesions. While some studies observed partial healing with conservative management, these cases often involved stable and small tears. In contrast, unstable lesions left untreated displayed persistent gaps on follow-up MRI and arthroscopy, correlating with poorer functional recovery [16,30].

Another notable concern is the underdiagnosis of ramp lesions, particularly when posterior portals are not routinely used during ACLR. Studies suggest that up to 40% of ramp lesions may be missed if inspection is limited to anterior portals, further compounding the problem of residual instability and suboptimal surgical outcomes [6,7,9].

Taken together, these findings underscore the importance of intraoperative detection and appropriate management of ramp lesions during ACLR. While the necessity of repairing stable lesions remains debated, most evidence supports active repair of unstable ramp lesions to optimize graft protection and joint biomechanics [22,30].

5. DISCUSSION

Ramp lesions of the medial meniscus, once considered relatively rare, have become a focal point of interest in orthopaedic literature due to their increasing detection rates and significant clinical implications. Their association with anterior cruciate ligament (ACL) injuries, particularly in the setting of ACL reconstruction (ACLR), has shifted clinical emphasis toward a more aggressive diagnostic and therapeutic approach. Across numerous studies, the prevalence of ramp lesions in patients undergoing ACLR has been reported to range from 16% to over 40% depending on the method of detection, with higher rates associated with systematic posteromedial exploration [4,6,9].

One of the most consistently supported findings across the literature is the necessity of surgical repair for unstable ramp lesions. Multiple studies have shown that untreated unstable lesions contribute to residual anterior knee laxity and may significantly compromise ACL graft integrity [5,15,18,22]. Repair, particularly when performed through a posteromedial portal using all-inside or inside-out suture techniques, has been associated with improved clinical outcomes, including higher Lysholm and IKDC scores, better subjective stability, and higher return-to-sport rates [20,22,24]. In contrast, stable ramp lesions have been shown in some studies to yield similar outcomes whether treated surgically or conservatively [16,31]. This divergence supports a nuanced, lesion-specific approach to treatment selection.

Accurate diagnosis remains a critical challenge. Ramp lesions often evade detection through standard anterior arthroscopic portals. Posteromedial visualization and trans-notch approaches dramatically improve sensitivity, particularly for "hidden" lesions that lie beneath the synovial membrane or fibrous cover [2,6,9]. Failure to diagnose and treat such lesions may contribute to ACL graft failure or persistent instability postoperatively. As a result, numerous authors have emphasized the necessity of routine posteromedial exploration during ACLR in high-risk patients, particularly those with chronic ACL insufficiency, steep medial tibial slope, or contact mechanism of injury [10,32].

Interestingly, beyond the biomechanical impact, recent evidence has emerged regarding the psychological benefits of ramp lesion repair. In a cohort comparison, patients undergoing ACLR with ramp lesion repair demonstrated significantly better psychological readiness to return to sport, as measured by the ACL-RSI scale, compared to those with isolated ACLR [33]. Although the functional performance did not differ significantly, the psychological confidence associated with comprehensive repair may play a crucial role in rehabilitation adherence and return-to-play outcomes.

Nonetheless, treatment decisions are still hampered by conflicting findings in the literature. For example, Ishibashi H. [31] reported no significant difference in postoperative knee stability between surgically and conservatively managed ramp lesions, even among patients with arthroscopically confirmed instability. However, these findings must be interpreted cautiously, as variations in lesion classification, surgical

technique, and follow-up durations may influence the outcomes. Additionally, some studies evaluated lesion stability solely from an anterior portal, potentially underestimating instability.

Another recurrent theme in the literature is the importance of timing. Early identification and repair of ramp lesions during ACLR appears to be associated with superior healing and biomechanical integration. Delayed repair or failure to recognize ramp lesions at the time of primary surgery may predispose patients to graft re-rupture, progressive instability, and need for revision procedures [15,22,30].

Despite growing clinical interest, limitations remain. Many of the included studies are retrospective cohort analyses or case series, often lacking control groups and standardization in diagnostic criteria. There is notable heterogeneity in surgical technique, lesion classification (e.g., Thaunat, Greif), and reported outcomes. Furthermore, long-term follow-up beyond two years is limited in most cohorts, making it difficult to assess the durability of surgical outcomes and the progression of osteoarthritis.

In conclusion, the current body of evidence supports a proactive approach to ramp lesion management, especially in the context of ACLR. While unstable ramp lesions should be surgically repaired, stable lesions may be monitored or treated with biological augmentation, depending on patient-specific factors. Given the biomechanical, clinical, and even psychological impact of these lesions, surgeons should maintain a high index of suspicion, employ advanced diagnostic techniques, and tailor treatment accordingly. Future high-quality prospective studies are needed to standardize treatment algorithms and optimize long-term joint preservation.

6. CONCLUSIONS

Ramp lesions of the medial meniscus are increasingly recognized as a prevalent and clinically relevant pathology, particularly in the context of anterior cruciate ligament (ACL) injuries. Improved arthroscopic techniques and heightened clinical awareness have led to detection rates of up to 42% in ACL-deficient knees.

Despite growing recognition, there is still no consensus on the optimal diagnostic and treatment strategies. Arthroscopic assessment via posteromedial or trans-notch portals remains the diagnostic gold standard, while MRI continues to show variable sensitivity despite recent advancements.

Surgical repair of unstable ramp lesions is supported by current evidence due to their biomechanical impact and potential to compromise graft integrity. However, the management of stable ramp lesions remains controversial, with some studies reporting similar short-term outcomes for conservative and surgical approaches.

Given the heterogeneity in classification systems, surgical techniques, and outcome measures, further high-quality, prospective studies are needed to:

- Establish a unified classification system for ramp lesions;
- Standardize diagnostic algorithms;
- Define clear indications for surgical versus non-surgical management;
- Assess long-term functional outcomes across different patient populations.

6.1 CLINICAL IMPLICATIONS

To assist decision-making in daily practice, the following recommendations can be derived from the current literature:

- Clinicians performing ACL reconstructions should maintain a high index of suspicion for concomitant ramp lesions, especially in chronic or contact injuries.
- Systematic inspection of the posteromedial compartment using trans-notch or posteromedial portals is advised during arthroscopy.
- Surgical repair is recommended for unstable ramp lesions due to their association with joint instability and graft failure.
- In stable lesions, individualized management should be based on patient age, activity level, and meniscal integrity.
- MRI findings should be interpreted with caution and not replace arthroscopic confirmation in cases with high clinical suspicion.

Ultimately, improving the quality and consistency of evidence will enable more individualized and evidence-based management strategies for this complex lesion type.

DISCLOSURE

AUTHORS' CONTRIBUTION:

Conceptualization: PK

Methodology: PK

Software: PK, AŚ, IB, AS

Check: PK, JN, AŚ, KK

Formal analysis: PK, AŚ, KK, AS

Investigation: PK, SL, LM, KC

Resources: PK, SL, LM, KC

Data curation: PK, JN, SL, LM

Writing -rough preparation: PK, IB, KSB, AS

Writing -review and editing: PK, KK, KC

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Supervision: PK

Project administration: PK, JN

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The authors declare no conflicts of interest.

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