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Review Article

Anteromedial Rotatory Instability of the Knee: A Scoping Review and Novel Technique for Arthroscopic Evaluation

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Abstract

Anterior Cruciate Ligament (ACL) tears are common in sports that involve pivoting, jumping or rapid direction changes, with concomitant injuries often complicating clinical management. Among these, damage to the deep Medial Collateral Ligament (dMCL) is a critical component in the development of Anteromedial Rotatory Laxity (AMRL), contributing to knee instability. This article examines the pathophysiology, clinical implications and management strategies for cases where ACL injuries are accompanied by dMCL injury and AMRL. An additional diagnostic test during arthroscopy is presented. We discuss the importance of recognizing and addressing these combined injuries to optimize functional recovery and minimize long-term complications, such as chronic instability and osteoarthritis.

Keywords: Anteromedial Instability; Anterior Cruciate Ligament (ACL); Medial Collateral Ligament (MCL); Arthroscopy; Knee

Introduction

Knee injuries involving the Anterior Cruciate Ligament (ACL) are common in athletes, with concomitant damage to other knee structures, such as the Medial Collateral Ligament (MCL), frequently observed. While the role of the MCL in providing medial stability to the knee is well established, the deep Medial Collateral Ligament (dMCL) plays a crucial, but often overlooked, role in stabilizing the knee against rotational forces [1,2]. Injury to the dMCL, in the presence of ACL tears, can result in a clinical syndrome of Anteromedial Rotatory Laxity (AMRL), a condition where there is excessive rotational motion of the tibia on the femur, leading to an unstable knee. The importance of diagnosing and also treating these concomitant injuries is still a matter of debate and various treatment options exist. Non-operative treatment of higher-grade MCL injuries resulted in higher re-rupture rates and therefore, residual instability should be avoided to protect the ACL and establish a favourable healing environment for the graft [3]. This article focuses on the impact of concomitant ACL and dMCL injuries, the pathophysiology of AMRL, diagnostic techniques and the treatment strategies required for optimal knee function and stability.

Pathophysiology

The knee joint's stability is maintained by both static and dynamic structures, including the ACL, MCL and the deep layer of the MCL, which is referred to as the dMCL. The ACL primarily controls anterior translation of the tibia relative to the femur and resists rotational forces. The MCL, including the dMCL, acts to stabilize the knee against valgus forces and external rotation. When the ACL is torn, the knee loses anterior stability, but without dMCL integrity, it also loses control over rotational movements, leading to excessive tibial rotation [3]. The dMCL, which is a key stabilizer against these rotational forces. Damage to the dMCL, especially in conjunction with an ACL tear, results in combined anterior and rotatory instability, manifesting as AMRL [4]. The combination of these injuries creates a scenario where both the anterior and medial stabilizers of the knee are compromised. This significantly alters the normal kinematics of the knee, increasing the risk for further injury and long-term degenerative changes. If untreated, AMRL can contribute to chronic knee instability, cartilage wear and early-onset osteoarthritis.

Clinical Presentation

Patients with combined ACL and dMCL injuries typically present with:

- Acute knee instability: Often following trauma involving hyperextension, twisting or cutting movements
- Medial knee pain: Localized to the medial aspect of the knee, particularly with twisting motions or deep squatting
- Instability symptoms: A feeling of the knee "giving way," especially during pivoting, cutting or jumping activities, which is indicative of rotatory instability [5]

Physical examination may reveal signs of both anterior and medial instability. Positive findings include:

- Lachman test or anterior drawer test: Indicating ACL insufficiency.
- Valgus stress test: Demonstrating pain or increased laxity on the medial side of the knee, suggesting damage to the dMCL
- Pivot Sloclcoum test: Highlighting anteromedial rotational instability and suggesting AMRL [6]
- In cases of significant dMCL injury, tenderness may be localized to the medial aspect of the knee

Diagnostic Evaluation

MRI is the gold standard for assessing ligamentous injuries. In the context of ACL and dMCL tears, MRI can provide detailed information about the extent of the injury, including the involvement of both the ACL and the superficial and deep layer of the MCL. Key features of a dMCL tear on MRI include thickening or discontinuity of the deep MCL fibers, often seen in conjunction with ACL disruption [4,7,8]. MRI may also reveal associated joint effusion and potential damage to the articular cartilage or menisci. Arthroscopy may be used to confirm the diagnosis, particularly when other imaging modalities are inconclusive. It provides direct visualization of both the ACL and MCL injuries, allowing for accurate staging and decision-making for surgical intervention.

Arthroscopic Evaluation of Anteromedial Instability Presentation of A Novel Diagnostic Technique

To facilitate the diagnosis of relevant concomitant dMCL injuries, the author presents a novel diagnostic tool. Applying external rotation torque to the lower leg in 90° of flexion will demonstrate AMRL. The subluxation of the medial tibia plateau reveals the posterior meniscus horn as a sign for relevant instability as demonstrated in Fig. 1.

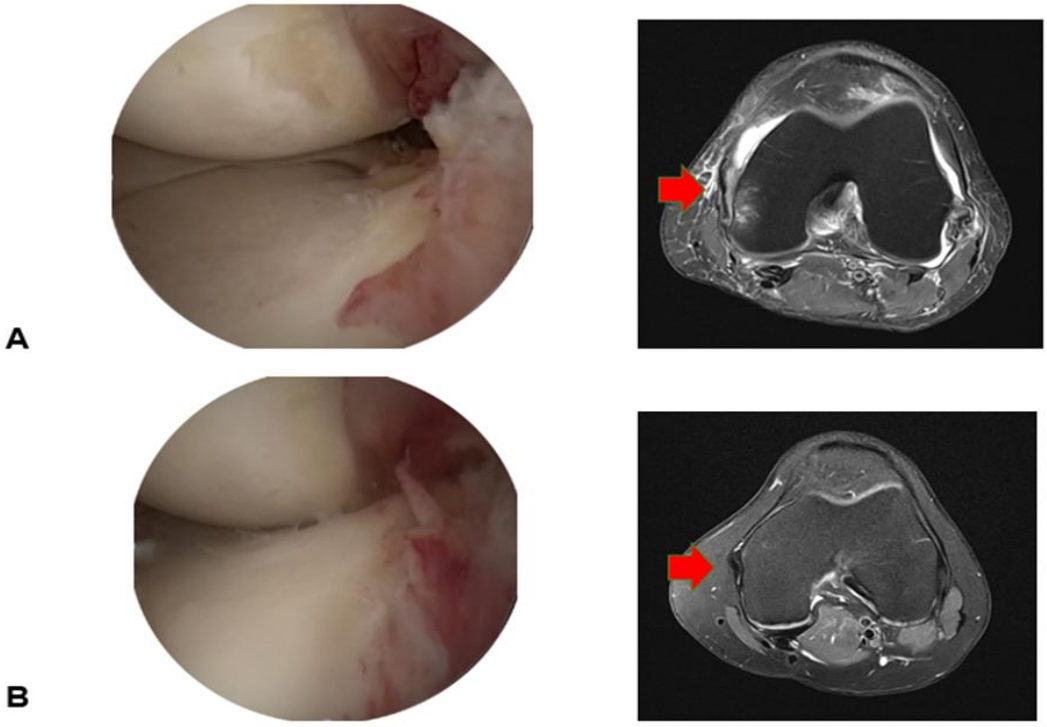

Figure 1: A) Positive posterior medial meniscus horn sign in 90° of flexion with external rotation torque as an indicator for anteromedial rotatory instability. Red arrow indicates deepdMCL lesion; B: Normal view with hidden posterior meniscus horn in anteromedial intact state.

Management and Treatment

The treatment of concomitant ACL and dMCL injuries, with or without AMRL, depends on the severity of the ligamentous damage and the patient's functional requirements. The goals of treatment are to restore knee stability, improve functional outcomes and prevent long-term joint degradation.

1. Non-Surgical Management

In patients with partial ACL and dMCL injuries, especially those with lower functional demands, conservative non-operative management may be considered due to good healing potential of the MCL. This typically includes physical therapy to improve strength and proprioception, along with bracing to provide medial and rotational support [9]. Non-surgical management is usually reserved for low-grade injuries or lower functional demands.

2. Surgical Management

For patients with significant ACL and dMCL injuries, surgery is generally indicated. The surgical management may involve:

- ACL Reconstruction: A standard procedure for restoring anterior stability to the knee. Various techniques, including single-bundle and double-bundle reconstructions, can be employed depending on the surgeon's preference and the specifics of the injury
- dMCL Repair or Reconstruction: The dMCL can be repaired or reconstructed based on the severity of the injury. In cases of acute tears, direct repair may be feasible, whereas more chronic injuries may require reconstruction. A combined approach that addresses both the ACL and the dMCL simultaneously is often necessary

Additionally, in cases of combined ACL and dMCL tears, surgeons may opt for a medial ligament reconstruction procedure to restore the stability of the medial compartment and address rotational instability. The repair or reconstruction of the dMCL should be done with careful attention to anatomical positioning to avoid recurrence of instability [5,6,10,11].

3. Rehabilitation

Postoperative rehabilitation is essential for achieving optimal functional outcomes. The rehabilitation program typically begins with efforts to reduce swelling and pain while restoring range of motion and strength. Early phases emphasize quadriceps and hamstring strengthening, while later stages focus on dynamic stabilization and return to sport-specific movements [9]. Rehabilitation for anteromedial rotatory laxity often includes exercises that enhance proprioception and rotational control to prevent future episodes of instability. A gradual return to sport is recommended after a comprehensive evaluation of knee stability and strength.

Conclusion

Concomitant ACL tears and deep medial collateral ligament injuries, particularly those that result in anteromedial rotatory laxity, present a unique challenge for clinicians. These injuries require a comprehensive and individualized approach, with early recognition and accurate diagnosis being crucial for successful management. The presented arthroscopic diagnostic evaluation facilitates the diagnosis and helps to guide treatment. Future researchinnovations intoas advanced imaging, surgical techniques and rehabilitation strategies including external rotation torque MRIs may standardize diagnosis will continue to improve outcomes for patients with these complex knee injuries. Surgical treatment involving ACL reconstruction combined with dMCL repair or reconstruction, followed by a structured rehabilitation program, can effectively restore knee stability and function. By addressing both the anterior and medial stabilizing structures, clinicians can reduce the risk of recurrent instability and prevent long-term complications such as joint degeneration and osteoarthritis.

Conflict of Interests

The authors declare that there is no conflict of interest related to this study.

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