

# **Evidence of Medial Meniscal Ramp Lesions and Posteromedial Tibia Plateau Bone Bruising in Multi-Ligament Knee Injuries with an Intact Anterior Cruciate Ligament: A Multi-Center Retrospective Case Series**

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## **INTRODUCTION:**

Multiligament knee injuries (MLKIs) are potentially limb-threatening injuries that most commonly occur from high-energy traumatic mechanisms. Medial meniscal ramp lesions, or meniscocapsular tears of the posterior horn of the medial meniscus, have gained particular attention in the setting of isolated anterior cruciate ligament (ACL) tears. Ramp lesions have been reported to occur concomitantly in 9 to 42% of isolated ACL injuries and if not addressed when present, can increase the risk for graft failure after ACL reconstruction. Despite the established harm untreated ramp lesions can impose on an ACL graft after an isolated reconstruction, the existence of ramp lesions in knee ligament injuries without evidence of an ACL tear is limited within the literature. As ramp lesions have a propensity to elude diagnosis, secondary signs have been reported in an effort to increase detection and recognition.

The purposes of this study were: (1) to evaluate the presence of ramp lesions in a series of MLKIs with an intact ACL and (2) to investigate and report on posteromedial tibia plateau (PMTP) bone bruises in the same cohort. We hypothesized that (1) MLKI patients with an intact ACL would show evidence of ramp lesions on MRI and that (2) >50% of patients with MRI diagnosed ramp lesions would contain PMTP bone bruising.

## **METHODS:**

A retrospective chart review was conducted on all patients surgically treated for MLKIs at two level I trauma centers from January 2001 to March 2021. A MLKI was defined as a complete rupture to two or more of the four major ligaments of the knee, including the ACL, PCL, superficial medial collateral ligament (sMCL), and/or the lateral (fibular) collateral ligament (LCL). All MLKIs were diagnosed on magnetic resonance imaging (MRI) and confirmed with operative reports. After the MLKIs were classified, patients were stratified into two separate cohorts: MLKIs with ACL injury and MLKIs with an intact ACL. ACL injury was defined as the presence of a partial and/or complete ACL tear on MRI and/or records of undergoing ACL reconstruction surgery. Conversely, an intact ACL was defined as having no evidence of a partial and/or complete ACL tear on MRI and no record of undergoing ACL reconstruction surgery. Only MLKIs with an intact ACL that received MRI scans within 90 days of the injury were included. Additionally, the presence or absence of a documented knee dislocation, which was defined as a tibiofemoral dislocation documented on initial radiographs and/or a documented reduction performed in the emergency room, was recorded. Similarly, the presence or absence of a peroneal nerve injury documented via physical exam was also recorded.

Two musculoskeletal radiologists retrospectively re-reviewed pre-operative MRIs for evidence of ramp lesions and PMTP bone bruises using previously established classification systems. Intra-class correlation coefficients (ICCs) were used to calculate the reliability among the reviewers. The prevalence of ramp lesions and PMTP bone bruises amongst the cohort was then calculated.

## **RESULTS:**

In total, 221 MLKIs were identified. 32 (14.5%) had an intact ACL (87.5% male; mean age of  $29.9 \pm 8.6$  years) and met the inclusion criteria for this study. The most common multi-ligament injury amongst this cohort was a combined injury to the posterior cruciate ligament (PCL) and posterolateral corner (PLC) (N=27, 84.4%). Additionally, 9/32 (28.1%) presented with a documented knee dislocation and 7/32 (21.8%) had a peroneal nerve injury noted on physical exam. PMTP bone bruises were seen in 12/32 (37.5%) patients. Ramp lesions were diagnosed in 12/32 (37.5%) MLKIs with an intact ACL, and 8/12 (66.7%) demonstrated evidence of a combined ramp lesion and PMTP bone bruise.

## **DISCUSSION AND CONCLUSION:**

While medial meniscal ramp lesions are most commonly associated with ACL injuries, 37.5% of 32 MLKIs with an intact ACL demonstrated evidence of a ramp lesion in this case series, confirming our primary hypothesis regarding the existence of MRI diagnosed ramp lesions in MLKIs with an intact ACL. PMTP bone bruises were observed in 66.7% of those with ramp lesions, confirming our secondary hypothesis that more than half of patients with ramp lesions would have posteromedial bone bruises. This is one of the first reports to suggest that ramp lesions exist without evidence of an ACL tear, and demonstrates the need to assess for potential ramp lesions at the time of ligament reconstruction in the ACL-intact MLKI.



Patients (N=32)	
Age at surgery (years), mean, $\pm$ SD	29.9 $\pm$ 8.6
Sex (Male, %, N)	87.5% (28)
BMI, kg/m <sup>2</sup> , mean, $\pm$ SD [range]	28.3 $\pm$ 5.6 [18.6-38.4]
Time between injury and MRI (days), mean $\pm$ SD, [range]	13.9 $\pm$ 23 [3-55]
High-Energy Mechanism of Injury (%, N)	65.6% (21)

Injury Patterns	Number of Patients (N=302)
PCL-PCL, N (N%)	27 (8.9%)
PCL-MCL	4 (1.3%)
PCL-MCL-PCL	1 (0.3%)
Documented Knee Dislocation	9 (2.9%)
Peroneal Nerve Injury	7 (2.3%)
Medial Meniscus Injury (not including ramp lesions)	9 (2.9%)
Lateral Meniscus Injury	11 (3.6%)

Legend: PCL = posterior cruciate ligament, PCL+ = posterolateral corner, MCL = medial collateral ligament

Patients (No./Sex)	MI/II Injury Type	Range (onset to MI/II)	PH/TP Bone Fracture	Separate MI/II Injury	LM Injury
1	PCL, PLC	N	N	N	Bucket Handle Tear
2	PCL, PLC	N	N	N	
3	PCL, PLC	Y	Y	N	Anterior and Posterior Radial Tears
4	PCL, PLC	Y	N	N	N
5	PCL, PLC	Y	N	N	N
6	PCL, PLC	Y	Y	Anterior Complex Tear <sup>a</sup>	Posterior Horn Tear
7	PCL, PLC	Y	Y	N	N
8	PCL, MCL	Y	Y	Posterior Root Tear	Anterior Horn Tear
9	PCL, PLC	Y	Y	N	N
10 <sup>b</sup>	PCL, PLC	Y	Y	N	N
11	PCL, PLC	Y	Y	N	N
12	PCL, PLC	Y	Y	N	N

**Legend:** Y = Yes, N = No, MRI = magnetic resonance imaging, MLKI = multi-ligament knee injury, PCL = posterior cruciate ligament, PLC = posterolateral corner, MCL = medial collateral ligament, PMTP = posteromedial tibial plateau, MM = medial meniscus (not including ramp lesions), LM = lateral meniscus. \*Complex tear description: "significant tearing and anteroposterior extrusion of the medial meniscus."