The Pathoanatomy of Medial Ligamentous Disruption in Multiligament Knee Injuries

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INTRODUCTION: Multiligament knee injuries (MLKIs) involving the medial-sided ligamentous structures of the knee pose significant challenges in terms of diagnosis and treatment. These include the superficial medial collateral ligament (sMCL), posterior oblique ligament (POL), and medial patellofemoral ligament (MPFL). Identifying and diagnosing posteromedial corner (PMC) injuries is critical to successful multiligament knee repairs and reconstructions. This retrospective study aimed to identify patterns of medial-sided injury, associated neurovascular complications, and fractures in acute MLKIs and knee dislocations (KD).

METHODS: Patients who underwent treatment for a MLKI or KD from two surgeons at two level-1 trauma centers were identified between January 2001 and May 2023. Only cases involving at least complete disruption of the sMCL were included. Demographic information, injury details, neurovascular status, laterality, and mechanism of injury were obtained.

RESULTS: A total of 92 patients with medial-sided knee MLKIs were included, with a mean age of 37.8 years. Documented knee dislocations were observed in 34.8% of cases, and fractures were present in 20.7% of patients. The most common combination of ligament injuries was ACL and sMCL (43.5%). Isolated sMCL tear occurred in 34.8% of patients, which included 12% that were proximal, 10.9% mid-substance, and 12% distal. Combined sMCL and MPFL tear was seen in 26% of patients, which included 14.1% proximal sMCL avulsions, 5.4% mid-substance injuries, and 6.5% distal avulsions. Combined sMCL and POL tear was seen in 12% of patients, including 1.1.% that were proximal sMCL avulsions, 3.3.% were mid-substance, and 7.6% distal. Combined sMCL, POL, and MPFL tear was seen in 27.2% of patients, which included 12% that were proximal sMCL avulsions, 9.8% mid-substance injury, and 5.6% tibial avulsions.

DISCUSSION: Overall, medial-sided injuries demonstrated a more balanced distribution of sMCL injury locations (proximal, mid-substance, distal) compared to previously investigated posterolateral corner injuries patterns, emphasizing the need for a meticulous evaluation of zone of injuries to these medially stabilizing structures. MPFL injury was associated with femoral avulsions more often than with mid-substance tears and patellar avulsions. This study provides valuable insights into the specific locations and patterns of medial-sided injuries in the MLKI which can aid in their diagnosis and management with an end goal of improved postoperative outcomes.

Limitations to this study include the fact that it relies on retrospective data and accuracy of this study assumes accurate documentation at time of injury. Furthermore, most of our patients experienced high- or low- velocity injuries, making conclusion about an ultralow- velocity injury difficult. However, our findings can still provide insight to clinicians at other level 1 trauma centers understand common patterns of injury in PMC injuries in MLKI patients.

SIGNIFICANCE/CLINICAL RELEVANCE: This retrospective describes the specific locations and patterns of medial-sided injuries in MLKIs which can aid in their diagnosis and management with an end goal of improved postoperative outcomes.

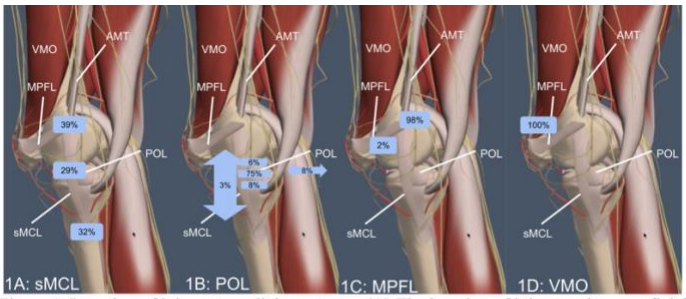

Figure 1. Location of injury to medial structures. (A) The location of injury to the superficial medial collateral ligament was observed in the following frequencies: 39% of injuries were femoral-sided injuries; 29%, a mid-substance tear; and 32%, tibial-sided injuries. (B) The location of injury to the posterior oblique ligament was observed in the following frequencies: 6% of injuries were femoral-sided injuries; 75%, a mid-substance tear; 8%, tibial-sided injuries; 8%, an axial tear, and 3%, a vertical tear. (C) 98% of medial patellofemoral ligament injuries were femoral-sided and 2% were diffuse. (D) 100% of vastus medialis oblique muscle injuries were mid-substance tears. Diagram courtesy of Primal Pictures™.

Table 1. sMCL Injury Location Based Upon Combined Injuries

Combined Injury	Femoral Avulsion	Mid-substance	Tibial Avulsion	Total
Isolated sMCL	11 (12.0%)	10 (10.9%)	10 (10.9%)	31 (33.7%)
sMCL and MPFL	12 (13.0%)	5 (5.4%)	6 (6.5%)	23 (25.0%)
sMCL and POL	1 (1.1%)	3 (3.3%)	7 (7.6%)	11 (12.0%)
sMCL, POL, and MPFL	11 (12.0%)	9 (9.8%)	5 (5.6%)	25 (27.2%)
sMCL and VMO			1 (1.1%)	1 (1.1%)
sMCL, MPFL, and VMO	1 (1.1%)			1 (1.1%)

Data presented as number (percentage). sMCL; superficial medial collateral ligament. POL; posterior oblique ligament. MPFL; medial patellofemoral ligament. VMO; vastus medialis oblique muscle. AMT; adductor magnus tendon. Gray boxes indicate 0 incidence.

Table 2. sMCL Injury Subclasses

Combined Injury	Class P	Class M	Class D	Total
Subclass 1: Isolated sMCL	11 (12.0%)	10 (10.9%)	10 (10.9%)	31 (33.7%)
Subclass 2: sMCL and MPFL	12 (13.0%)	5 (5.4%)	6 (6.5%)	23 (25.0%)
Subclass 3: sMCL and POL	1 (1.1%)	3 (3.3%)	7 (7.6%)	11 (12.0%)
Subclass 4: sMCL, POL, and MPFL	11 (12.0%)	8 (8.7%)	5 (5.6%)	24 (26.1%)

P = proximal sMCL tear, M = midsubstance sMCL tear, D = distal sMCL tear