# Multiligamentous Knee Injury

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# Disclosures

- Consultant for Arthrex

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# Outline

- Types
- Anatomy
- Evaluation and Assessment
- Treatment
- Post-operative rehabilitation


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# Definition

- Defined as a tear of two or more of the four major ligamentous structures about the knee
  - Anterior Cruciate Ligament (ACL)
  - Posterior Cruciate Ligament (PCL)
  - MCL
  - LCL
  - Posteromedial Corner (PMC)
  - Posterolateral Corner (PLC)

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# Causes

- High energy
- Low velocity
- Ultra-low velocity

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# Epidemiology

- Increasing rates of injury in literature
  - .001 events/100 pt years (Kennedy 1963)
  - .0125 events/100pt years (Levy 2009)
  - .072 events/100 pt years (Arom 2013)
- 53-72% are males
- 17% open vs 83% closed

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# Associated Injuries

- Vascular Injury (up to 30%)
- Nerve Injury (up to 40%)
- Fractures (60%)

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# Classification

- Timing
  - Acute < 3 weeks
  - Chronic > 3 weeks
- Force
  - Low Energy
  - High energy
- Open Vs. Closed

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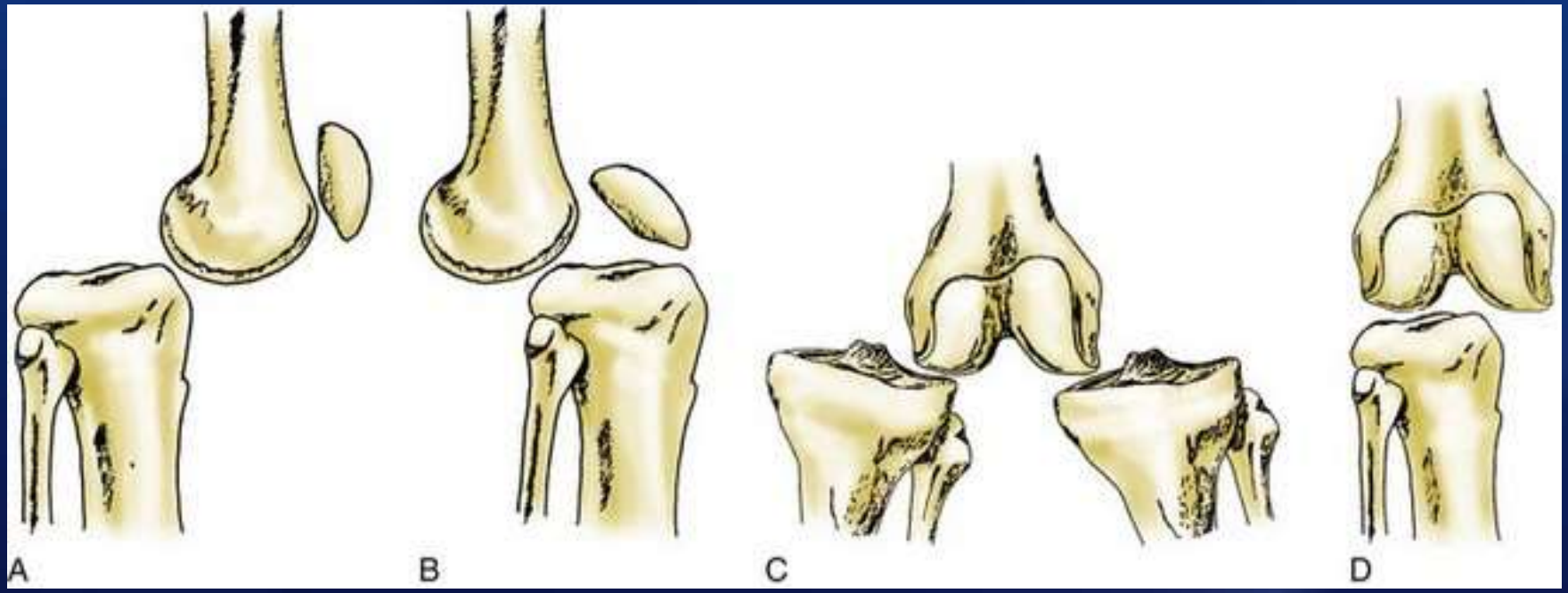
# Kennedy Classification

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# Schenck Classification

| Table. Anatomically Based Knee Dislocation Classification System | |
|---|---|
| KD-I | Single cruciate + collateral injury |
| KD-II | ACL and PCL injury |
| KD-III M | ACL, PCL, and MCL injury |
| KD-III L | ACL, PCL, and LCL + PLC injury |
| KD-IV | ACL, PCL, MCL, and LCL + PLC injury |
| KD-V | Dislocation + fracture |

***Abbreviations:*** *ACL, anterior cruciate ligament; LCL, lateral collateral ligament; MCL, medial collateral ligament; PCL, posterior cruciate ligament; PLC, posterolateral corner.*

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# ACL Anatomy

- 2 bundles
  - AM: tight in flexion
    - Restrain anterior tibial translation
  - PL: tight in extension
    - Rotational stability
- 90% of knee dislocations involve the ACL
- Leads to loss of restraint in the A-P direction and rotational stability


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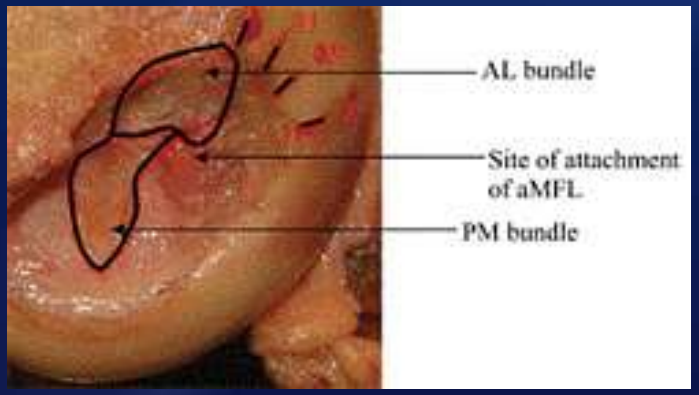
# PCL Anatomy

- Keystone to ligamentous stability of the knee in MLI
- Central pivot point for knee
- Injury leads to translational, rotational and coronal instability
- 78-87% of all knee dislocations

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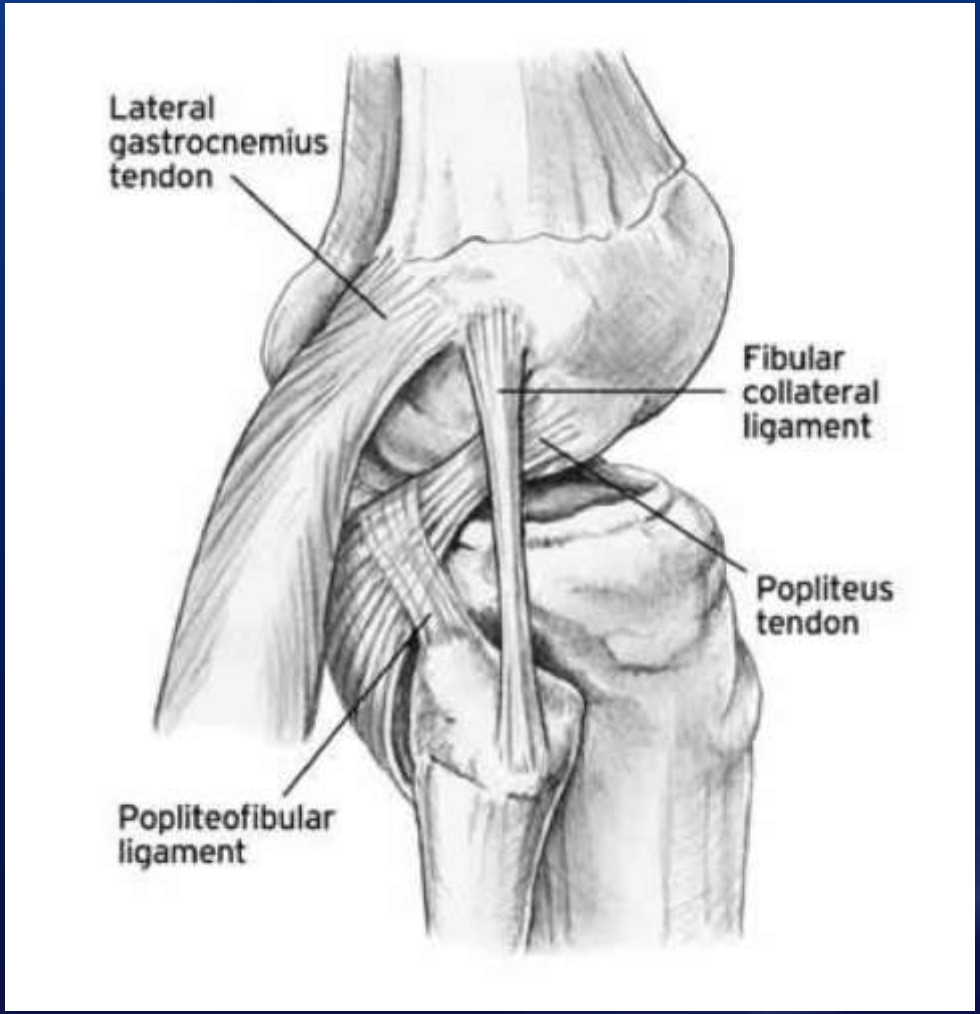
# Anatomy

| Lateral Structures of the Knee | |
|---|---|
| Layer I | - IT band<br>- Biceps femoris<br>- Fascia |
| Common peroneal nerve runs between layer I and II | |
| Layer II | - LCL<br>- Patellar retinaculum<br>- Patellofemoral ligament |
| Lateral geniculate artery runs between layer II and III | |
| Layer III | - Arcuate ligament<br>- Coronary ligament<br>- Popliteus tendon<br>- Popliteofibular ligament<br>- Capsule |

# Posterolateral Corner



# Anatomy

- Medial side typically thought of in three layers, however they blend together

| Medial Structures of the Knee | |
|---|---|
| Layer I | **Deep fascia** of thigh enclosing **Sartorius**<br>- Anteriorly blends with medial patellar retinaculum<br>- Posteriorly blends with deep fascia covering gastroc |
| Gracilis, semitendinosus, saphenous nerve run between layer I and II | |
| Layer II | - Superficial MCL<br>- Semimembranosus<br>- Posterior oblique ligament |
| Layer III | - Deep MCL<br>- Capsule<br>- Coronary ligaments |

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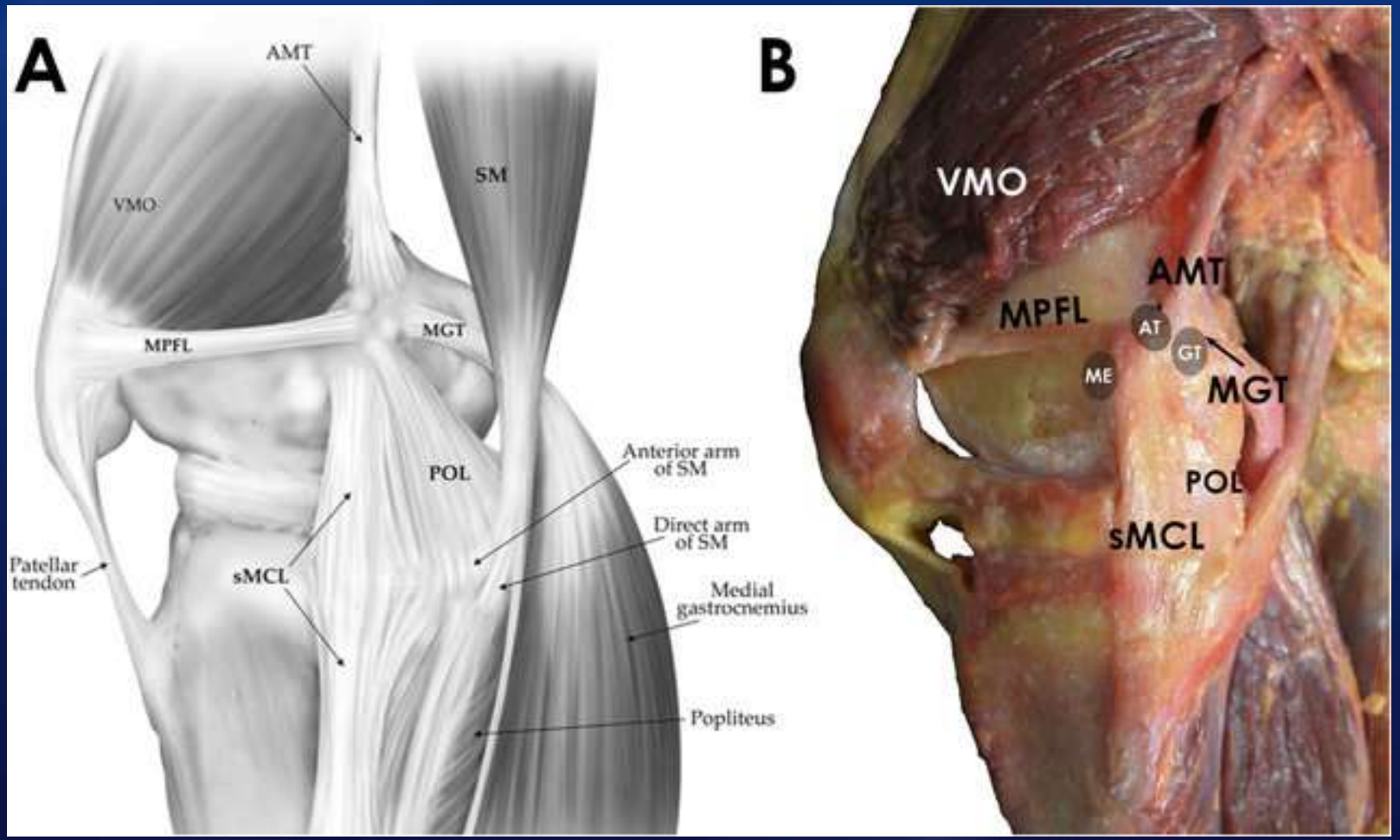
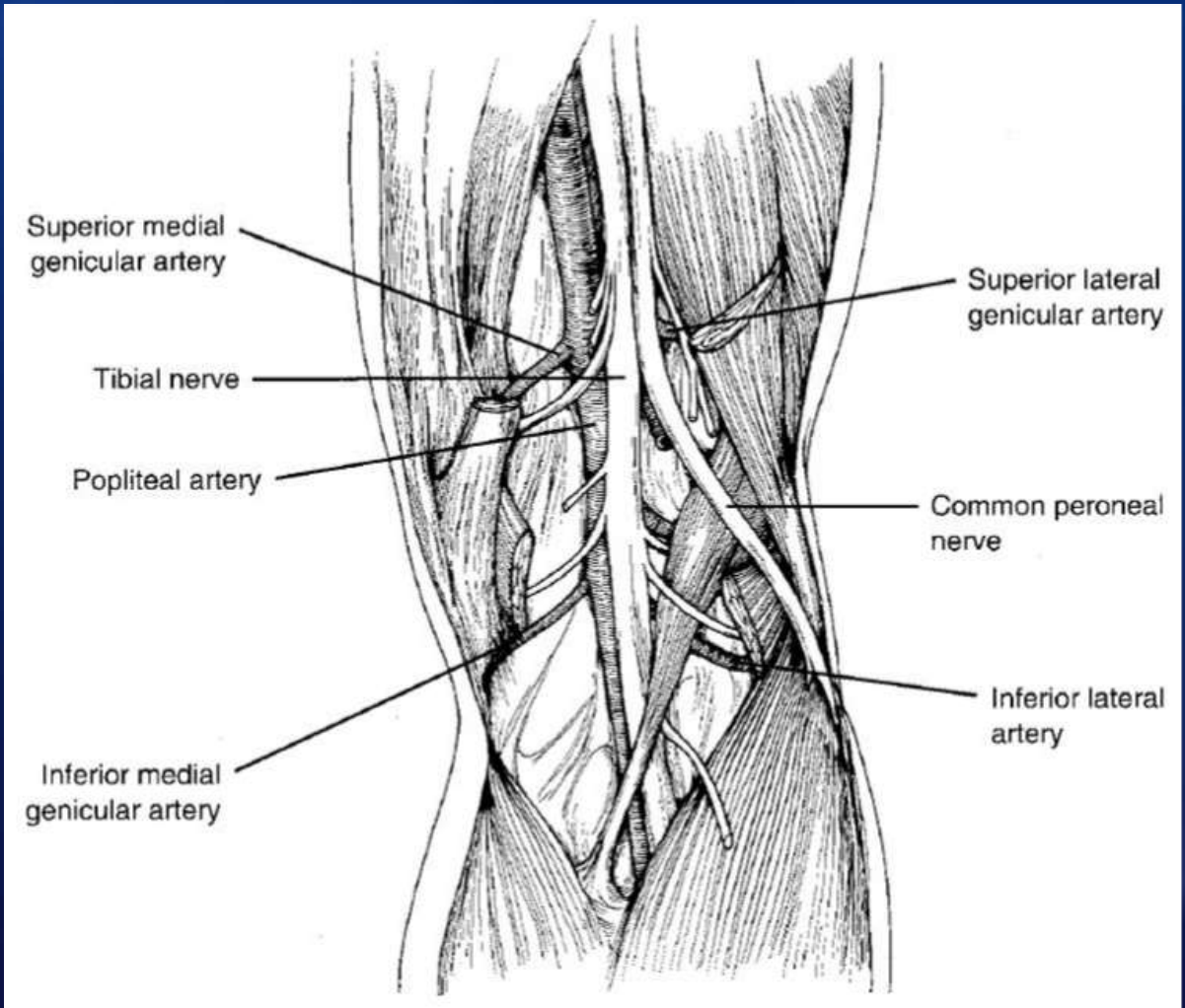
# Posteromedial Corner



# Posterior Knee Anatomy

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# Evaluation and Assessment

- Need high index of suspicion, especially in low energy injuries
  - 50% of knee dislocations reduce spontaneously prior to evaluation
- High energy injuries are typically evaluated by ATLS protocol initially
- Tertiary exam can often pickup more subtle injuries
- Missed diagnosis with delayed treatment can be catastrophic

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# Vascular Injuries

- Vascular injuries described in 5-32% of MLI
- KDIII-L injuries have the highest rate of vascular injury
- 20-30% could result in limb amputation, increasing to 80% is ischemia is greater than 8 hours.
- The rate of vascular injury requiring surgical intervention estimated at 5.63%
- Obesity and open injuries increase risk of vascular injury

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# Evaluation

- Neurovascular status should be evaluated immediately
  - Posterior tibial pulse, Dorsalis pedis pulse, and distal nerve function
- Prompt reduction of dislocation is imperative
- Reduction can be attempted/performed without x-rays in patients without pulses (on field)

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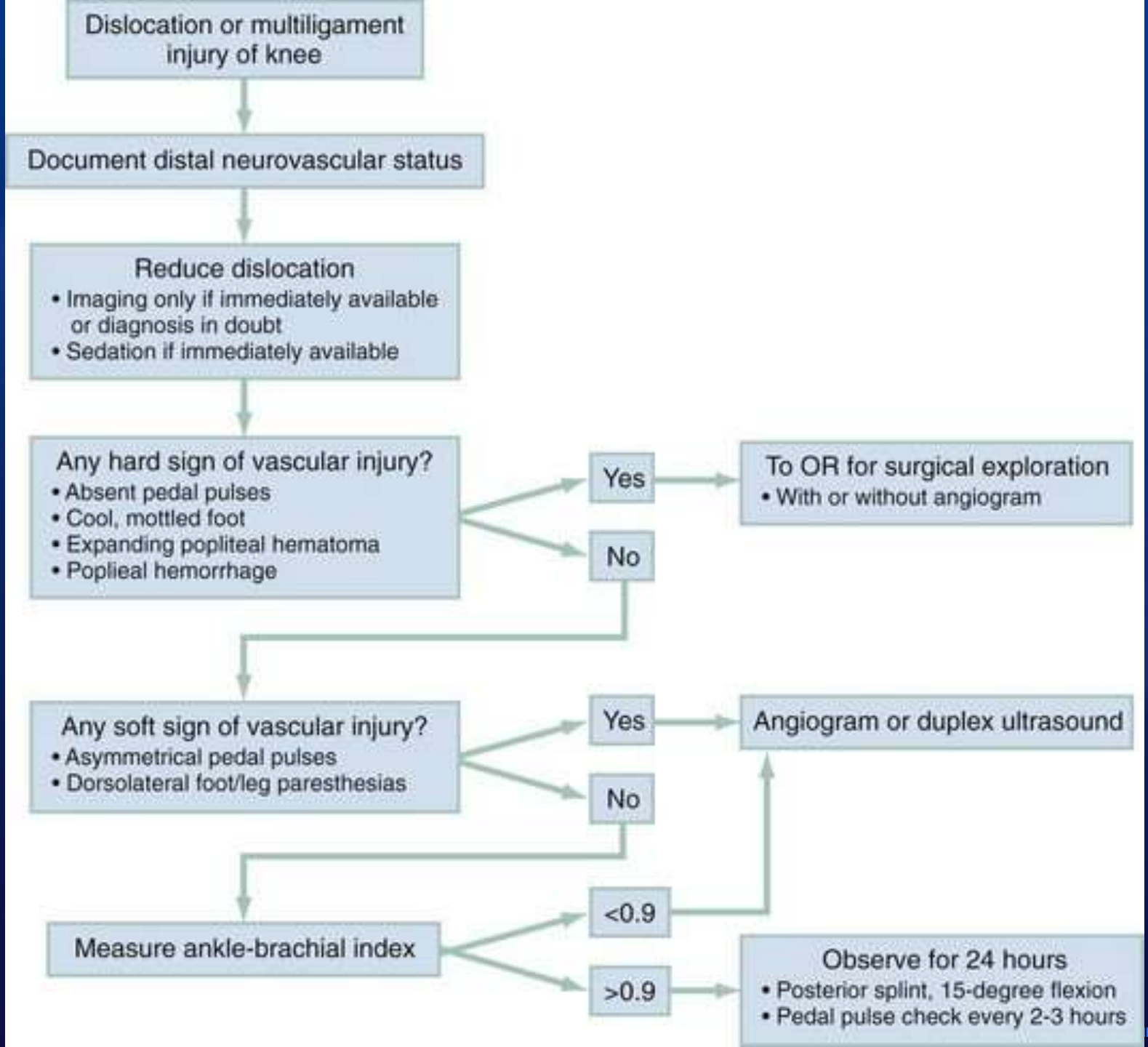
Dislocation or multiligament injury of knee
Document distal neurovascular status
Reduce dislocation
• Imaging only if immediately available or diagnosis in doubt
• Sedation if immediately available
Any hard sign of vascular injury?
• Absent pedal pulses
• Cool, mottled foot
• Expanding popliteal hematoma
• Poplieal hemorrhage
Yes
To OR for surgical exploration
• With or without angiogram
No
Any soft sign of vascular injury?
• Asymmetrical pedal pulses
• Dorsolateral foot/leg paresthesias
Yes
Angiogram or duplex ultrasound
No
Measure ankle-brachial index
<0.9
>0.9
Observe for 24 hours
• Posterior splint, 15-degree flexion
• Pedal pulse check every 2-3 hours

# Common Peroneal Nerve Injuries

- 14-40% of MLI develop CPN injury
- 31-75% of CPN injuries spontaneously improve
- Younger age is the only factor that predicts better outcomes


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# Electorphysiology Testing

- Electromyography (EMG) and Nerve Conduction Velocity (NCV)
  - Baseline at 6 weeks if deficiency continues
  - Repeat at 3 and 6 months if recovery not full
    - Positive sharp waves
    - Fibrillation potentials
  - Chronic denervation
    - Fasciculations

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# CPN Injury Treatment

- AFO
- PT to prevent equinovarus deformity

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# Surgery for CPN Injury

- Neurolysis if PLC going to be reconstructed
- 95% improved 1 strength grade for dorsiflexion
- Nearly 50% improved 3 strength grades
- Good results seen even 3 months after injury

- *Thoma et al. Plast and Rec Surg 2001*

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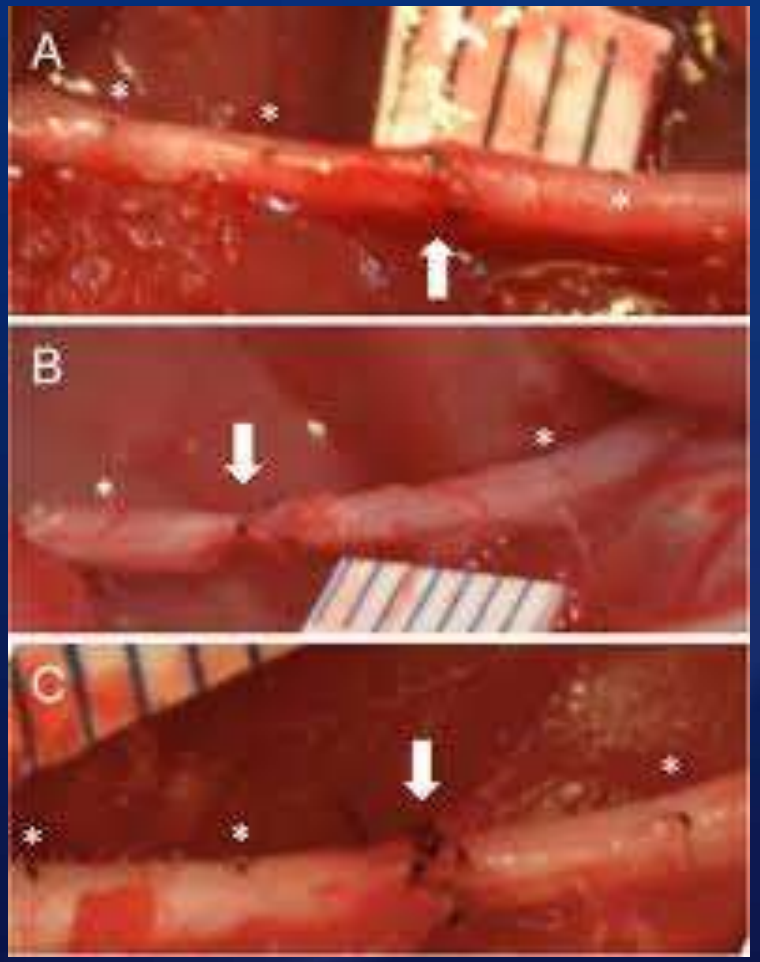
# Nerve Repair

- End to end repair
- CPN not in continuity and zone of injury is small
  - 16 of 19 patients increased motor strength by 3 grades or higher
  - Repair can be done up to 12 months (3-6 months best)

*Kim et al. Neurosurg 2004*

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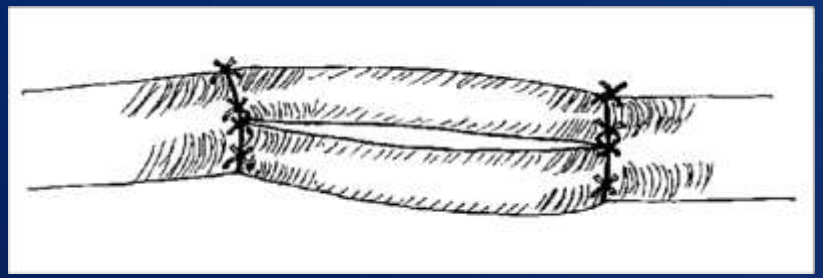
# Nerve Grafting

- Cable Grafting
- After 3 months with no improvement and no clinical or electrical evidence of CPN re-inervation
  - 75% increased strength by 3 grades if graft <6 cm
  - 38% if 6-12cm
  - 16% if 13-24cm



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# Stabilization

- Knee should be stabilized post reduction and standard radiographs performed
  - Knee immobilizer
  - External Fixator

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# Surgical Emergencies

- Vascular injury
- Compartment syndrome
- Irreducible dislocation (rare)
- Open injury

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# Physical Exam

- Thorough evaluation of all ligaments is necessary
- Most reliable examination is immediately following injury (least amount of post-traumatic swelling)
- Complete tertiary examination
- Understand mechanism

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# Anterior Cruciate Ligament

- Anterior Drawer
- Lachman
- Pivot Shift

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# Posterior Cruciate Ligament

- Posterior Drawer
- Posterior Sag
- Dial Test

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# Medial/Lateral Collateral Ligament

- Varus and Valgus stress at 0 degrees and 30 degrees

- Grade I – 0-5 mm of opening
- Grade II – 5 to 10 mm of opening
- Grade III – >10 mm of opening

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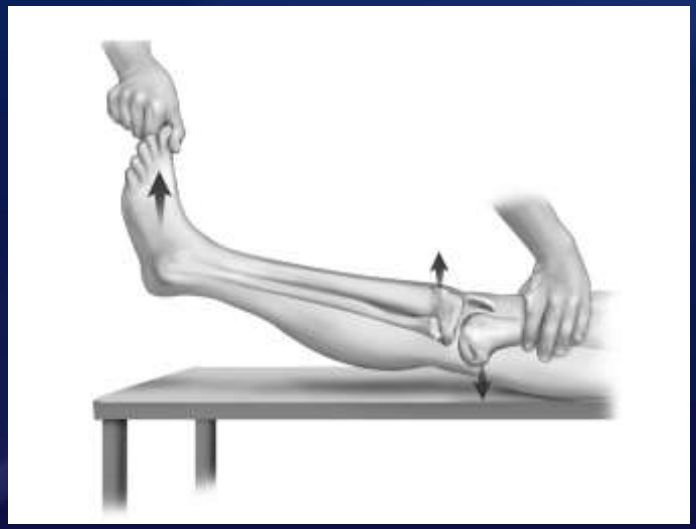
# Posterolateral Corner Injury

- External Rotation Recurvatum Test
- Dial Test





# Imaging

- Radiographs
  - Fractures
  - Tibial spine avulsion
  - PCL avulsion
  - MCL avulsion
  - Gerdy's avulsion
  - Biceps, LCL avulsion
  - Segond fracture
- MRI once patient is able
- Patients with chronic injuries require alignment films

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# Treatment

- When?
- What?
  - Non-operative versus Operative
  - Structures to repair/reconstruct
- How?
  - Staged versus one setting
  - Repair versus reconstruction
  - Allograft versus autograft
  - Surgical technique

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# Goals of treatment

- In order of importance
  1. To save one's leg (vascular intervention)
  2. To get the patient back to everyday life activities without pain
  3. To get back to low-impact activities (bicycle, swimming, elliptical, walking)
  4. To higher impact activities without contact (running, basketball, etc)
  5. To get back to all sporting, including contact activities. (Karate, Jiu Jitsu, Football, etc)

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# Non-operative treatment

- Should be considered in the following patients:
  - Critically ill patients
  - Patients with multiple comorbidities that may preclude surgical intervention
  - Certain injury patterns (ie ACL/MCL) in low demand patients or those with significant OA
- Protected early mobilization is key

Am J Knee Surg. 2001 Winter;14(1):33-8.

**Operative versus nonoperative treatment of knee dislocations: a meta-analysis.**

Dedmond BT[1], Almekinders LC.

Sports Med Arthrosc. 2011 Jun;19(2):167-73. doi: 10.1097/JSA.0b013e3182107d5f.

**Outcomes of operative and nonoperative treatment of multiligament knee injuries: an evidence-based review.**

Peskun CJ[1], Whelan DB.

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# Surgical Timing

- Acute versus chronic (<3 weeks, >3 weeks)
- Early surgery (<3 weeks) resulted in higher Lysholm knee scores, IKDC scores, Sports activity scores

J Bone Joint Surg Am. 2004 Feb;86-A(2):262-73.

**Surgical management of knee dislocations.**

Harner CD[1], Waltrip RL, Bennett CH, Francis KA, Cole B, Irrgang JJ.

Arthroscopy. 2009 Apr;25(4):430-8. doi: 10.1016/j.arthro.2009.01.008.

**Decision making in the multiligament-injured knee: an evidence-based systematic review.**

Levy BA[1], Dajani KA, Whelan DB, Stannard JP, Fanelli GC, Stuart MJ, Boyd JL, MacDonald PA, Marx RG.

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# Staged Treatment Versus One setting

- Studies that support both staged treatment and one stage surgery
- Biomechanical studies cite increasing stress on repaired/reconstructed ligaments for staged tx

Am J Sports Med. 2002 Mar-Apr;30(2):233-8.

**The effect of injury to the posterolateral structures of the knee on force in a posterior cruciate ligament graft: a biomechanical study.**

LaPrade RF[1], Muench C, Wentorf F, Lewis JL.

Am J Sports Med. 1999 Jul-Aug;27(4):469-75.

**The effects of grade III posterolateral knee complex injuries on anterior cruciate ligament graft force. A biomechanical analysis.**

LaPrade RF[1], Resig S, Wentorf F, Lewis JL.

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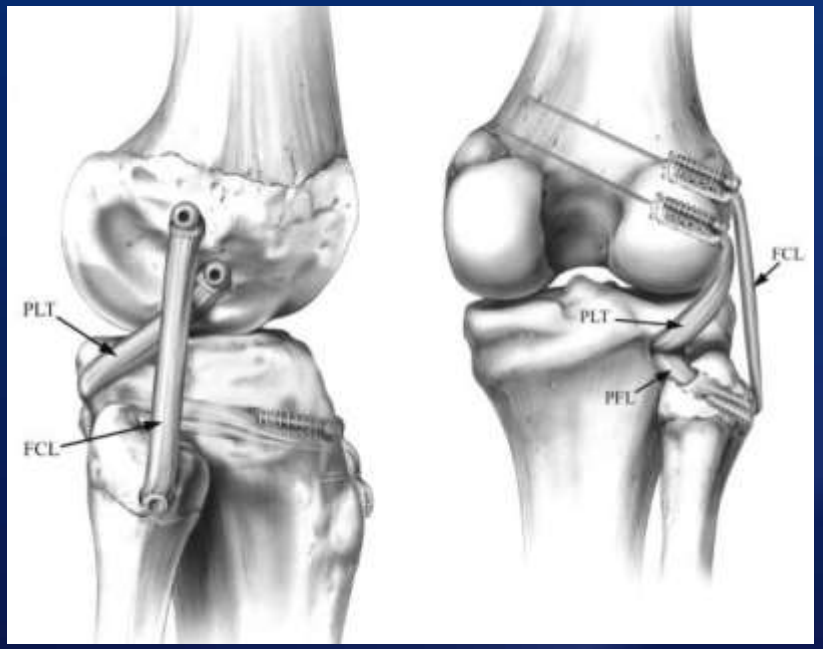
# Repair Versus Reconstruction

- Repair of the ACL/PCL is not recommended as multiple studies have demonstrated poor results
- PLC repair 37-40% failure rate vs 6-9% for reconstruction

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# Allograft versus Autograft

- No consensus in literature
- Due to number of structures reconstructed, often not enough autograft tissue
- Cross sectional study noted majority perform allograft reconstruction (74%)

Knee Surg Sports Traumatol Arthrosc. 2015 Oct;23(10):2983-91. doi: 10.1007/s00167-014-3451-1. Epub 2014 Nov 27.

**Surgical treatment of multiligament knee injuries.**

Cook S[1], Ridley TJ[2], McCarthy MA[3], Gao Y[4], Wolf BR[5], Amendola A[6], Bollier MJ[7].



 

# Summary

- Surgery
- Acute
- One setting
- Reconstruction
- Allograft

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# Post-Operative Rehabilitation

- 8 days locked in extension
  - Pain control, inflammation control
  - Gait training
- Protected weight bearing 6 weeks
- PT starting at day 8 with Hinged knee brace
- Goal of 0-90 degrees by 2 weeks
- RTP and activity varies dependent on patient injury, surgeon preference.
- No studies demonstrating one rehab technique superior, most important --> move early

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# Outcomes

- After surgery, the overall activity level is reduced
- Surgery can restore stability and ROM allowing for ADLs without pain.

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# Return to Work

- 88% return to work but may require modification of work place or job responsibilities.
  - 62% with little or no modification

*Everhart et al. Arthroscopy 2018*

- 90% were able to perform light labor while 65% were able to perform heavy labor

*Neri et al. Clin Sports Med 2019*

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# Return to Sport

- 46-68% RTS

*Everhart et al. Arthroscopy 2018*

*Stannard et al. Am J Sports Med 2005*

- 65% RTS but only
- 29% of athletes participating in high-level sports were able to return to same level

*Neri et al. Clin Sports Med. 2019*

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# Factors Associated with Poor Outcome

- Non-op treatment
- Delayed surgery
- Higher injury severity
- Neurovascular injury
- Obesity
- Age >30

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# CONCLUSIONS

- MLI can be associated with high-energy injuries
- Watch for ultra-low velocity MLI in obese people
- Vascular status must be closely followed to avoid limb threatening injuries.
- Injury to CPN is common and negatively affects outcomes
- Acute reconstruction of the ligaments is the procedure of choice.

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# QUESTIONS?


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