Outline

- Clinical Presentation
- Acute and Subacute Management
- Posteromedial Corner
- Posterolateral Corner
- Outcomes
- Complications
Clinical Presentation
Clinical Presentation

**Significant injuries**

- 20-30% vascular injury
  - 85% limb loss if not addressed w/in 8 hours
- 30-40% neurologic injury
  - only 30% with full recovery
- With non-op treatment:
  only 50% RTW, 15% return to sport

*Cooper et al 1825: “…recommend immediate amputation for irreducible or open dislocations”*
Clinical Presentation
Classification

Direction

- *Tibia relative to femur*
Clinical Presentation

Anterior

- Most common
- 30-50% of dislocations
- Usually due to hyperextension
  - Kennedy et al. JBJS 1963:
    - Capsule ruptures beyond 30 deg
    - Popliteal artery ruptures beyond 50 deg (tethered at adductor and popliteal hiatus)
Clinical Presentation

Posterior

- **30-40% of dislocations**
  - *Usually due to dashboard mechanism*
  - PCL is always torn
  - Vascular injury is common (up to 50%)
    - Usually an intimal injury secondary to contusion
Clinical Presentation
Medial/Lateral

~10-20% of dislocations

- Usually involve one collateral and one or both cruciates
  - Often associated with plateau or SC fractures

- Lateral dislocations with high rate of peroneal nerve injury

- Medial dislocations with 25% rate of vascular injury
Clinical Presentation
Rotatory

~3-5% of dislocations

- Posterolateral dislocation may be irreducible
  - MFC buttonholes through the anteromedial joint capsule
  - MCL falls into joint space (dimples skin) & blocks reduction
Clinical Presentation
Classification – *Schenck and Wascher*

- **Ligament injury pattern**
  - **KDI:** multilig without bicruciate
  - **KDII:** bicruciate
  - **KDIII:** bicruciate + medial or lateral side
  - **KDIV:** “round the world”
  - **KDV:** +fx

**TABLE 1**
Modified Knee Dislocation (KD) Classification System

<table>
<thead>
<tr>
<th>Class</th>
<th>Ruptured</th>
<th>Intact</th>
</tr>
</thead>
<tbody>
<tr>
<td>KDI</td>
<td>Usually ACL and LCL, PCL, ± MCL, LCL/PLC</td>
<td>PCL, ACL</td>
</tr>
<tr>
<td>KDII</td>
<td>ACL and PCL</td>
<td>MCL, LCL/PLC</td>
</tr>
<tr>
<td>KDIII</td>
<td>M: ACL, PCL, MCL</td>
<td>LCL/PLC</td>
</tr>
<tr>
<td>KDIV</td>
<td>L: ACL, PCL, LCL/PLC</td>
<td>MCL</td>
</tr>
<tr>
<td>KDIV</td>
<td>ACL, PCL, LCL/PLC, and MCL</td>
<td>None</td>
</tr>
<tr>
<td>KDV</td>
<td>.1 Periarticular fracture with PCL intact</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.2 Periarticular fracture with bicruciate injury</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.3M Periarticular fracture with tears of ACL, PCL, and posteromedial corner</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.3L Periarticular fracture with tears of ACL, PCL, and LCL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.4 Periarticular fracture with tears of ACL, PCL, LCL, and MCL</td>
<td></td>
</tr>
</tbody>
</table>
Clinical Presentation
Classification

**Mechanism**

- High velocity (MVAs)
- Low velocity (sports)
- Ultra-low velocity/high energy (morbid obesity)
Acute and Subacute Management
Acute Management

**Closed reduction**
- Pre and post NV exam
- Immobilize post-reduction (usually a hinged knee brace)

**Spanning ex-fix if…**
- Open dislocation
- Vascular injury
- Inadequate reduction or poor tolerance of brace (obese, burns)
Vascular Injuries

Common

- Rate of vascular injury
  - Stannard et al JBJS 2004:
    prospective cohort 126 patients
    - 0% KDI and II
    - 2% KDIII
    - 16% KDIV
    - 3% KDV

- Potentially devastating
  - Battlefield data: >50% limb loss if not addressed within 8 hours
Vascular Injuries
Assessment

Physical Exam

- **Stannard et al JBJS 2004:** prospective cohort, 19 mo F/U
  - “+” exam = ANY decrease in pulses, color or temperature, expanding hematoma, or abnl exam noted in ED
    - If exam +, arteriogram obtained
    - If exam -, admitted for serial exams x 48 hrs (if change in exam, arteriogram obtained)

- **Miranda et al JOT 2002:** prospective cohort
  - “+” exam = “hard signs” of absent pulses, distal ischemia, active hemorrhage
    - If exam +, arteriogram
    - If exam -, admitted for serial exams x 24 hrs
Vascular Injuries
Assessment

What about non-occlusive (ie. Normal exam) intimal tears?

- Lohmann et al 1990: normal exam with 2 cases of pulseless leg after tourniquet let down
  - Progression of intimal tear
- Johansen et al: occur in 6%
- Sawchuk et al: 3% of these progress to clinical significance

**Conclusion:** Physical Exam is extremely valuable, but is not perfect
Vascular Injuries

Which imaging studies to get?

- **Arteriogram:**
  - Sensitivity 95%, specificity 90%
  - Cons: pseudoaneurysm, renal contrast load

- **Magnetic Resonance Angiogram (MRA)**
  - *Tocci et al JKS 2010:* an acceptable alternative to angio
  - Cons: takes longer, not readily obtainable in unstable patients

- **CT Angiogram**
  - >90% sensitive/specific
  - Cons: radiation exposure, contrast
Neurologic Injury

- Typically Common Peroneal
  - Recovery is variable, but generally poor (30%)
  - If no recovery by 6 wks, consider EMG
    - Repair if evidence of transection

Figure 3. Peroneal nerve innervation. A, superficial peroneal nerve. B, deep peroneal nerve.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
<th>Anatomic Lesion</th>
<th>Time to Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurapraxia</td>
<td>Mild: local loss of nerve conduction without axonal degeneration.</td>
<td>Normal-appearing nerve</td>
<td>Full recovery in hours to days</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>usually, possibly as long as 6-12 weeks.</td>
</tr>
<tr>
<td>Axonotmesis</td>
<td>Moderate: axonal damage without damage to axonal supporting structures. Wallerian degeneration occurs.</td>
<td>Nerve in gross continuity may appear stretched or confused.</td>
<td>Full recovery in several weeks to months; regeneration at 1 mm per day.</td>
</tr>
<tr>
<td>Neurotmesis</td>
<td>Severe: complete transection of the nerve.</td>
<td>Epineurium may be intact or nerve is completely transected.</td>
<td>Spontaneous recovery very unlikely.</td>
</tr>
</tbody>
</table>
For younger, active patients, operative management results in improved outcomes...

  - Improved stability, Lysholm/IKDC scores in surgically treated patients
  - Some loss of motion

- *Richter et al 2002:*
  - Improved instrumented laxity, Lysholm/Tegner
  - Improved RTW (85% vs. 50%), return to sports (56% vs. 17%)
Subacute Management
Op vs. Non-op

...best outcomes in sports dislocations:
- *Hirschmann et al AJSM 2010*: 26 elite athletes with sports-related KDIII dislocations
  - 79% returned to sport at median 5.5 months
  - 13% with >15 degree loss of flexion, 8% with >10 deg loss of ext
  - Only 30% reached pre-injury level of play

Worst outcomes track with older, higher energy injuries:
- *Richter et al*: pts >40 with 65% poor outcomes (Lysholm)
- Be wary of the unhealthy elderly, obese dislocation
  - Risk/benefit ratio favors non-op in many of these
Subacute Management
Timing of Reconstruction

Usually dictated by other injuries
- Recovery and clearance from Vascular
- Meniscus, non-op MCL

Several studies suggest early reconstruction/repair results in best outcomes…

- *Chabra et al, Harner et al JBJS 2004:*
  - Subjectively: 85% G/E results in pts treated in < 3 wks vs. 60% G/E in delayed mgmt
  - Higher rate of MUA in acute group, but no diff in motion at 5 yrs

- *Hirschmann et al AJSM 2010: higher return to sport if addressed within 40 days*
In House Protocol

What do you do to get it ready for referral?

- **Acute management**
  - Closed reduction, figure out vascular status

- **Immobilization + DVT prophylaxis**
  - Hinged knee brace if not ex-fixed
  - ASA or Lovenox

- **Imaging**
  - MRI
  - Vascular study (MRA or CTA, whichever is more convenient), if possible

- **PT**
  - IF NO EX-FIX: WBAT and START ROM (in brace)
In House Protocol
What do you do to get it ready for referral?

FOLLOW-UP APPT. WITHIN 2 WEEKS OF INJURY

***Especially if no MRI
Posteromedial Corner
Posteromedial Corner
MCL, POL, Semimembranosus

- Primary components
  - MCL (superficial and deep)
  - Semimembranosus
  - Posterior Oblique Ligament (POL)
Primary restraint to **valgus** loading

- In extension: POL, posterior sMCL
  
  - Greatest load in extension is posterior femoral attachment of sMCL (most common injury location)

- In 30 deg flexion: remaining sMCL and dMCL

Secondary restraint to excessive **tibial ER**
Likely protects the ACL

- Battaglia et al AJSM 2004: grade II MCL injuries increase load on ACL 50-60%
- Sims et al AJSM 2006: ACL tears associated with grade III MCL injuries in ~80%
Posteromedial Corner
Biomechanics

Grading
- Valgus loading at 0 and 30 deg of flexion
  - Grade I: 0-5 mm opening
  - Grade II: 5-10 mm opening
  - Grade III: >10 mm opening
- Increased opening in extension suggests POL laxity
- Increased opening only in 30 flexion suggests isolated MCL
Posteromedial Corner
Biomechanics

- Valgus Stress 0 and 30
- Anteromedial Rotatory Instability (AMRI)
  - Anterior drawer in ER
  - Look for increased anterior translation of MTP

Positive findings suggest injury to POL
Medial “gap” test
- Valgus stress at 30 causes lift-off of the MM
Posterolateral Corner
Posterolateral Corner
LCL, PFL, Popliteus, Lateral Capsule
Posterolateral Corner Biomechanics

*Resists combined posterior tibial translation, varus and ER*

**Varus:**
- LCL is the primary restraint to varus, maximal effect at 30 deg flexion
- Posterolateral capsule resists varus in 0 deg flexion

**External rotation:**
- LCL is the primary ER restraint at 0-30
- Popliteus and PFL at 60-90

**Notes:**
- Isolated PCL insufficiency will not increase tibial ER at any angle (ie. Increased ER spin with a posterior drawer indicates more than just a PCL injury)
Posterolateral Corner Biomechanics

**Backs up the ACL**

- *LaPrade et al AJSM 1999:* sectioning the PLC significantly increases graft forces on reconstructed ACL
  - Greatest effect in extension

- *Kannus et al, LaPrade et al:* Increased failure rates noted in primary ACL reconstruction with unrecognized PLC deficiency
Posterolateral Corner Biomechanics

Backs up the PCL

- **Harner et al**: significant strain on reconstructed PCL after injury to the PLC (150% increase in graft forces)
  - Popliteus is most important component
    - **Markolf et al**: PCL graft forces not returned to normal unless LCL reconstruction combined with either popliteus or PFL graft

- **Noyes et al AJSM 2005**: most common cause of failed PCL reconstructions = unrecognized PLC deficiency
Posterolateral Corner
Physical Exam

Varus:
- Varus loading at 0 and 30 deg of flexion
  - Grade I: 0-5 mm opening
  - Grade II: 5-10 mm opening
  - Grade III: >10 mm opening

Tibial ER:
- Dial or ER spin at 30 and 90 deg
  - Grade I: <10 degrees TFA Asymmetry
  - Grade II: 10-20 degrees TFA Asymmetry
  - Grade III: >20 degrees TFA Asymmetry
Posterolateral Corner
The “Dial Test” Explained

Gollehon et al, Grood et al:
- **Isolated PCL injury** = no change in ER at any flexion angle
- **Isolated Posterolateral Corner injury** = increased external tibial rotation at all angles
  - Max effect at 30 deg of knee flexion (13 deg, vs. 5 deg ER at 90 deg of flexion)
- **Posterolateral Corner PLUS PCL** = increased external tibial rotation at all angles, but increased MORE at higher flexion
  - Max effect at 90 deg of knee flexion (20 deg)
Posterolateral Corner
Physical Exam

- **Reverse Pivot Shift**
  - Start with tibia subluxed (flexion, ER, valgus)
  - As knee is brought into extension, ITB reduces tibia

- **ER Recurvatum**
  - Extension of knee results in PL tibial subluxation
Posterolateral Corner Imaging

Plain films:
- Look for lateral joint space widening (+/- varus stress views)
- Fibular head avulsion

MRI:
- LCL on coronal cuts
- Try to determine location of popliteus injury (axial cuts)
Posterolateral Corner
LCL, PFL, Popliteus, Lateral Capsule

LaPrade et al: 100% of grade III PLCs with + drive through

≥10 mm opening
OUTCOMES
**Motion**

- 0-125 degrees *(Noyes et al, Walker et al, Shelbourne et al)*
- Up to 60% requiring MUA+/- LOA (esp. in acute with MCL)

**Stability**

- Most studies show instrumented laxity within 5 mm of the other side for ACL, MCL, PLC in more than 70% of patients
  - Most variability is with the PCL
    - *Fanelli et al*: mean 2.6 mm difference on posterior drawer
    - *Noyes et al*: 30% with >3 mm difference
Outcomes

- **Pain**
  - Persistent pain in up to 10% (chondral, motion)

- **Return to work**
  - 50-70% \((\text{Levy et al})\)

- **Return to sports**
  - Variable, largely dependent on patients
    - \textit{Levy et al}: high energy = 30%
    - \textit{Hirschmann et al}: sports related KDIIIs = 79% (but most at a lower level)
Index of Suspicion

- 31 yo male
- Presented to ED 3 times in one week with dislocation but self-reduction
- KDIV with subsequent DVT
Summary

- **Potentially limb-threatening injuries**
  - Early management is focused on stable reduction with a focus on vascular status and treatment of associated injuries

- **Combined repair and reconstruction usually results in improved outcomes**
  - If conditions allow, operative intervention in the first month is preferable

- **Always balance risk/benefit**
  - Outcomes are NOT the same as after an ACL
  - Some patients will do better without surgery
Thank You