Knee Dislocations

Mauricio Kfuri, MD, PhD

James P. Stannard, MD
Learning Outcomes

• At the end of this presentation, the learners should:

  • Understand the mechanisms of injury associated with a knee dislocation;

  • Recognize the importance of a comprehensive neurovascular assessment while dealing with a knee dislocation;

  • Develop a rationale for decision making in cases of dislocated knees
Mechanism of Injury
High Energy Trauma

- Direct anterior tibial blow
- Posterior tibial translation
- Higher likelihood of PCL tear
- Popliteal artery contusion
- Possible arterial intimal tear
Low Energy Trauma

• 29yo, female
• Morbidly obese
• Low energy fall
• Knee dislocation with
  • Popliteal artery tear
  • Compartment syndrome
• Results in Knee disarticulation
• Be thorough in obese patients with low energy trauma!

Core Curriculum V5
Diagnosis
Diagnosis

• History: Mechanism of injury

• Physical exam
  • Look for areas of abrasion (anterior tibia)
  • Tenderness
  • Lower extremity swelling
  • Knee effusion
  • Knee instability or asymmetrical laxity
Diagnosis

In a great number of cases the knee is not dislocated at admission.

The majority (50 to 80%) reduce spontaneously at the scene of trauma.

Pay attention to clinical signs: swelling, effusion, tenderness, instability.

It is easy to overlook!
Knee Radiographs

One should suspect the existence of a knee dislocation when radiographs depict asymmetrical joint spaces.

It is easy to overlook!

One should suspect the existence of a knee dislocation when radiographs depict bony avulsions.
Associated Injuries

- Vascular: 5 to 15%
- Neurological: 20 to 40%
- Soft tissues: 15 to 35%
- Bone: 16%

Rihn, 2004 ¹ Robertson, 2006 ² Natshuhara, 2014 ³
Initial Assessment
Priorities!!!

• Vascular status of the limb
• Neurologic status of the limb
• Rule out compartment syndrome
Vascular Assessment

Vascular Injuries in Knee Dislocations: The Role of Physical Examination in Determining the Need for Arteriography

By James F. Stannard, MD, Todd M. Sheils, MD, Robert R. Lopez-Ben, MD, Gerald McGwin Jr, PhD, James T. Robinson, and David A. Volgas, MD

Repeated clinical assessment of the knee in the first 48 hours

Angiography only for cases with compromise of perfusion
After Knee Reduction

Normal Pulse
Perfusion is normal

Rigorous
Follow-up

If pulse becomes questionable

Arteriography

Abnormal Pulse

Good Perfusion

Arteriography

Bad Perfusion

Surgical Exploration

Barnes CJ, 2002
Vascular Assessment

Ankle Brachial Index

$\text{ABI} = \frac{\text{doppler systolic arterial pressure in injured limb (ankle)}}{\text{doppler systolic arterial pressure in uninjured limb (brachial)}}$

$\text{ABI} < 0.90$

Indication for CT angiography

Mills et al. 2004
Measuring the ABI

• The patient is placed supine

• Evaluate the pulses by palpation. Pulses may be considered normal, diminished (compared with the contralateral limb), or absent.

• Next, a blood pressure cuff is placed proximal to the ankle of the injured limb.

• The systolic pressure is determined with a Doppler probe at either the posterior tibial artery or the dorsalis pedis artery.

• The same measurement is performed on the ipsilateral uninjured upper extremity, measuring the systolic pressure at the brachialis artery.

• The ABI is obtained by dividing the pressure of the injured lower limb by the pressure of the uninjured upper limb
• Intimal tears of the popliteal artery may initially not be flow limiting.

• In case of high suspicion (altered ABIs), consider a CT angiography

• If non limiting flow intimal tear is confirmed by CT angiography: observe the patient closely, keep vascular team aware, and do not use tourniquet at the time of any reconstructive knee surgery.

• At admission, in cases of absent perfusion...
  • Emergent surgical exploration
Vascular and Nerve Injury After Knee Dislocation

A Systematic Review

Omar Medina BS, Gabriel A. Arom BS,
Michael G. Yeranosian MD, Frank A. Petrigliano MD,
David R. McAllister MD

Meta-analysis 862 patients

Incidence of vascular injury: 18% (171 patients)

80% of cases of vascular injuries required surgical repair

12% of cases with vascular injuries resulted in amputation
Vascular injuries associated with dislocation of the knee.

✔ Amputation rate

➢ Surgery in the first 8 hours = 11%

➢ Surgery after 8 hs = 86%

Message:
Don’t delay a surgical exploration if there is no limb perfusion after reducing a knee dislocation.
Neurological Assessment

✓ Incidence of Nerve Injury 4.5% – 40%
  ✓ 21% complete recover
  ➢ 29% partial recover
  ➢ 50% did not recover

✓ Surgical procedure: Neurolysis (most of the times performed in association with posterolateral corner reconstruction)

Lachman JR et al., 2015
Differentiate between complete and incomplete nerve palsy determines the prognosis
Peroneal Nerve Injury in the Setting of Knee Dislocations

Physical Exam

Partial Nerve Palsy

- Observe
- Consider Later Tendon Transfer

Future meniscoligamentous repair / reconstruction

Complete Nerve Palsy

Electromyography (EMG) Testing

- No motor action potentials

Ultrasound Testing to Assess Nerve continuity

1. Complete Nerve Discontinuity
2. Time from injury to possible surgery is less than 3 months

Direct Nerve Transfer

O’Malley et al. 2016 11
Cases that should be taken to the OR immediately:

- Irreducible knee dislocation
- Open knee dislocation
- Associated vascular injury – no perfusion to the limb
- Compartment syndrome
Irreducible Knee Dislocation

Dimple Sign

Skin depression on the medial side of the knee

Typical case of rotatory instability of the knee.

The medial femoral condyle buttonholes the medial capsule and the medial collateral ligament (MCL) protrudes into the knee joint.

This requires open reduction!!
Open Knee Dislocation

- Urgent reduction of the knee at the ER
- Immediate neurovascular assessment (before and after reduction)
- Urgent surgical management = open fractures
  - Irrigation and Debridement
  - Provisional stabilization: spanning fixator
  - Image studies: radiographs/MRI
Associated Vascular Injury

• At the time of the vascular repair:
  • Knee should be reduced
  • Knee should be spanned with an external fixator
  • Fasciotomies may be considered pending on time of ischemia, and characteristics of the soft tissues
Compartment Syndrome

• The knee should be reduced

• A provisional spanning external fixator secures the reduction

• Fasciotomies: the four compartments of the leg should be released
Knee dislocations: Classification
Timing

• Acute < 3 weeks

• Chronic > 3 weeks
## Classification - Kennedy

**Tibial position with respect to the femur**

<table>
<thead>
<tr>
<th>Position</th>
<th>Description</th>
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<tbody>
<tr>
<td>Anterior</td>
<td>It is not applicable if the knee is reduced at patient’s admission.</td>
</tr>
<tr>
<td>Posterior</td>
<td>Up to 80% of the knee dislocations reduce spontaneously before patient’s admission.</td>
</tr>
<tr>
<td>Medial</td>
<td></td>
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<tr>
<td>Lateral</td>
<td>It does not describe which structures have been torn</td>
</tr>
<tr>
<td>Rotatory</td>
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<tr>
<td>(Combination)</td>
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</table>

Kennedy et al, JBJS 1963 \(^{12}\)
Anterior Knee Dislocation

50% of all knee dislocations
If Hyperextension > 50 degrees...

Popliteal Artery Tear

Kennedy et al, JBJS 1963
Posterior Knee Dislocation

Mechanism: Dashboard

30% of all knee dislocations

Arterial injury possible due to the intimal tear

Non rare: Extensor mechanism disruption

Kennedy et al, JBJS 1963
Schenck Classification

Based on clinical evaluation under anesthesia

Supports the Decision Making

**KD I:** Either ACL or PCL are intact

**KD II:** Only ACL and PCL are torn

**KD III:** Both ACL and PCL and either Posterolateral (KD III L) or Posteromedial (KD III M)

**KD IV:** ACL + PCL + PMC + PLC

**KD V:** Association between articular fracture and knee dislocation

Schenck et al., Instr Courses Lectures 1999 13
Decision making
At patient’s admission...

- Reduce the joint
- Complete neurovascular evaluation
- Evaluation of the soft tissues: attention to open injuries and the “dimple sign”
- ABIs
- Knee radiographs
- Rule out emergent needs to a surgical trip to the OR
Closed reduction of knee dislocations

• Gentle manual traction

• Avoid pressure over the popliteal fossa

• Careful anterior translation of the bone located posteriorly

• Make sure to document the presence of pulses before and after reduction
After close reducing the knee...

• ... keep it reduced!

• Brace may be difficult in individuals with increased BMI or with some degree of soft tissues compromise

• Spanning external fixator should be considered if the knee may not stay stable with a brace.
Before definitive ligament reconstruction...

• Deep venous thrombosis (DVT) prophylaxis
  • Low molecular weight heparin
  • Should be administered from during the entire interval between spanning external fixator and definitive reconstruction of the knee

• In case there is documented DVT
  • A consideration should be given to an inferior vena cava filter placement with chemical anticoagulation

Collins et al, 1992 15 ; Sems et al, 2009 16 ; Levy et al., 2010 14
Ligament Repair versus Reconstruction
Bone avulsions: Repair

*PCL Avulsion*

*PCL Repair*
Mid-substance Tears

- Acute repair: peripheral structures (capsule, peel off injuries)
- Corners should be reinforced with reconstruction
Posterolateral Corner: Repair vs Reconstruction

The Posterolateral Corner of the Knee

Repair Versus Reconstruction

James P. Stannard,* MD, Stephen L. Brown, MD, Rory C. Farris, MD, Gerald McGwin, Jr, PhD, and David A. Volgas, MD

From the Department of Surgery, Orthopaedic Division, University of Alabama at Birmingham, Birmingham, Alabama


Failure rate of 9% (2/22) with reconstruction versus 37% (13/35) in repairs (p=.03)

Conclusion: Results with repair followed by early motion rehabilitation have been significantly inferior when compared with results from reconstruction using the modified 2-tailed technique. The authors now use reconstruction rather than repair in the majority of patients who sustain posterolateral corner tears after high-energy injuries.
Posterolateral Corner: Repair vs Reconstruction

Repair Versus Reconstruction of the Fibular Collateral Ligament and Posterolateral Corner in the Multiligament-Injured Knee

Bruce A. Levy,* MD, Khaled A. Dajani, MD, Joseph A. Morgan, Jay P. Shah, MD, Diane L. Dahm, MD, and Michael J. Stuart, MD

From the Department of Orthopaedic Surgery, Mayo Clinic, Rochester, Minnesota


45 PLC injuries, 17 excluded
28 knees with data
  Repair in 10, 4 failures (40%)
  Reconstruction in 18, 1 failure (6%)

Conclusion: Our series demonstrated a statistically significant higher rate of failure for repair compared with reconstruction of the FCL/PLC. Reconstruction of the FCL/PLC structures is a more reliable option than repair alone in the setting of a multiligament knee injury.
Posterolateral Instability: When should you repair?

Avulsion of a large bone fragment from the fibula – ORIF with screw and washer

If allograft is not available in your hospital and you don’t have adequate autograft available

If only repair, consider holding motion
Posterolateral Corner: Anatomy

3 Key Structures:
- Fibular Collateral Ligament (FCL)
- Popliteofibular Ligament (PFL)
- Popliteus Tendon

Popliteus
Isometric versus Anatomic

• It is critical to determine where you anchor the reconstruction in the femur to avoid a change in graft length with flexion/extension

• Dror Paley

• Cadaveric study

Isometric Point
Intersection between Blumensaat line and the projection of the posterior femoral cortical
Results Posterolateral Corner

• Negative (shortening) measurements in red
• Significant difference between anatomic and fluoro methods
  • \( p = 0.000176 \)
• Fluoro more accurate by more than 3 mm of excursion
• Nine knees (47%) had excursion > 4 mm using the anatomic method
• One knee (5%) had excursion > 4 mm using the radiographic method

<table>
<thead>
<tr>
<th>Knee #</th>
<th>Anatomy</th>
<th>Fluoro</th>
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<tbody>
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Median  
Mean  
Std. Dev.  
P Value
Modified Two-tailed Technique

- Graft passed through fibula, up to isometric point with suspensory fixa
- Separate popliteus graft if needed
- Tighten FCL in 20 - 30° of flexion and neutral internal rotation
- Tighten popliteus in extension
- Reconstructs the posterolateral corner
  - Stannard et. al. 2020 20
In this biomechanical study, double bundle PCL reconstructions more closely replicated the ex vivo biomechanical functions of the native ligament immediately after implantation.

Double bundle suspensory fixation technique replicated most closely the native PCL.
Hinged External Fixation in the Treatment of Knee Dislocations

A Prospective Randomized Study

James P. Stannard, MD, Clayton W. Nuelle, MD, Gerald McGwin, PhD, and David A. Volgas, MD

Level I Prospective study

Hinged knee brace versus hinged external fixation

Less failures with hinged external fixation
Hinged External Fixator – For very unstable knees
Timing for Definitive Ligament Surgery

Conflicting literature

- **Acute Repair/Reconstruction** – Performed within the first three weeks of the injury – when tissues are still identifiable without significant scarring;

- **Staged Repair/Reconstruction** – Consists in repairing/reconstructing the peripheral ligaments followed by delayed cruciate ligament reconstructions once the range of motion is restored;

- **Delayed Reconstruction** – Performed once the peripheral soft tissues have some degree of healing, and the knee has complete range of motion
Critical aspects to be considered

• The PCL determines the reference knee axis of rotation

• The PCL reconstruction takes precedence over the ACL, as it will determine a reference alignment between the tibia and the femur
Case Example

• Female, 34yo
• Left Varus Knee Dislocation
• Peroneal Nerve Injury
• Posterolateral corner injury (Lateral Collateral + Biceps Tendon)
Revisiting the Schatzker classification of tibial plateau fractures

Mauricio Kfuri\textsuperscript{a,b,*}, Joseph Schatzker\textsuperscript{c} \textsuperscript{23}

\textsuperscript{a} Department of Orthopedics, University of Missouri, Columbia, MO, United States
\textsuperscript{b} Department of Biomechanics, Medicine and Rehabilitation of the Locomotor System, School of Medicine of Ribeirão Preto, University of São Paulo, Ribeirão Preto, Brazil
\textsuperscript{c} Division of Orthopedics, Sunnybrook Health Sciences Center, University of Toronto, Ontario, Canada
Type IV A
Posterolateral Corner Injury
Fracture dislocation: widened tibial plateau
Lateral translation of the tibia
Instability = Lack of containment

Compromise of the anteromedial tibial rim
Instability = Lack of containment
Reducing the tibial subluxation

Periarticular clamp applied to the medial femoral epicondyle and to the anterolateral tibial rim
Restoring the Tibial Containment

Anteromedial buttress

Horizontal plate to buttress the rim
6 months PO

No pain

Stable joint

0 to 120 degrees of flexion

Tibial plateau fixation +

Posterolateral corner repair and reconstruction
Take home messages
Knee Dislocations

Easy to overlook!!

50% -80% of the cases are spontaneously reduced at hospital admission
Knee Dislocations

Should be always suspected:

1. High energy polytrauma
2. Unexpected knee swelling, tenderness, effusion
3. High energy tibial plateau fractures
4. Polytrauma patients with hip dislocation (dashboard mechanism)
Knee Dislocations

At admission:

1. Detailed, documented vascular assessment: pulses, perfusion, ABIs

2. Repeated vascular assessment every four hours. Admit the patient!

3. Document the neurological status of the patient (sensation and motricity)

4. Reduce the knee as soon as possible if dislocated. Document pulses before and after!
Knee Dislocations

Emergencies that should be taken to the Operation Room:

1. Vascular injury

2. Compartment syndrome

3. Open knee dislocation

4. Irreducible knee dislocation (lateral dislocation, medial dimple sign)
Knee Dislocations

Once reduced:

1. Hinge knee brace if suitable

2. Spanning external fixator (very unstable knees, morbid obese patients, open injuries)

3. Hinge external fixator: in association with multiligament knee reconstruction, specially in cases of vascular repair
Knee Dislocations

Stage 2: Definitive ligament reconstruction

1. Three to four weeks after initial injury

2. Will be dictated by soft tissues envelope and overall patient’s clinical status

3. Posterior cruciate ligament is the critical structure to determine the proper relationship between tibia and femur

4. Peripheral ligaments should be reconstructed and not only repaired

5. Anterior cruciate ligament may be performed in a staged manner, allowing for early motion after reconstructing PCL and corners
Knee Dislocations

Schenk V

1. Understand the complexity of the injury: MRI

2. In case of tibial plateau fractures: fix the fracture, examine the knee under anesthesia

3. Consider reconstructing the corners (especially the posterolateral corner in association with a varus fracture dislocation - Kfuri/Schatzker types IV P or IV A)
References


References


Acknowledgment

The authors would like to thank Stacy Turpin Cheavens, MS, CMI, Certified Medical Illustrator University of Missouri, Department of Orthopedic Surgery for some of the illustrations included in this presentation.
Thank you!

University of Missouri, Columbia