Knee Dislocations

Mauricio Kfuri, MD, PhD

James P. Stannard, MD

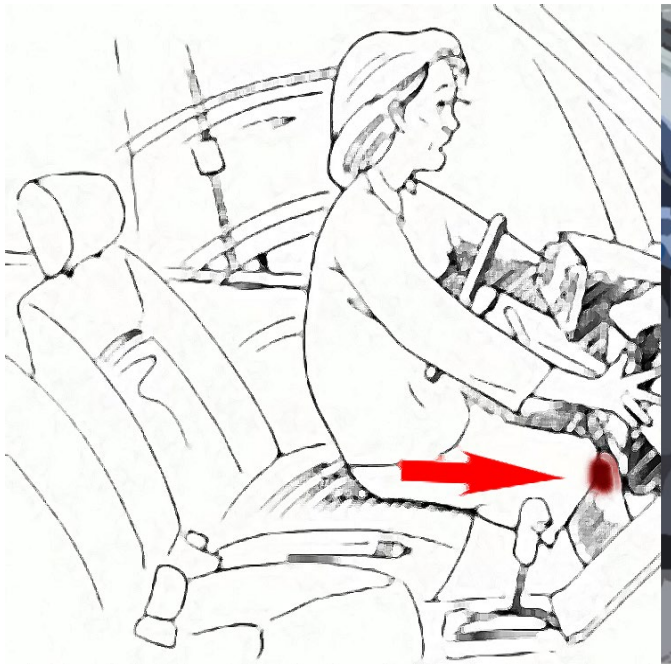
Missouri Orthopaedic Institute
University of Missouri Health Care

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

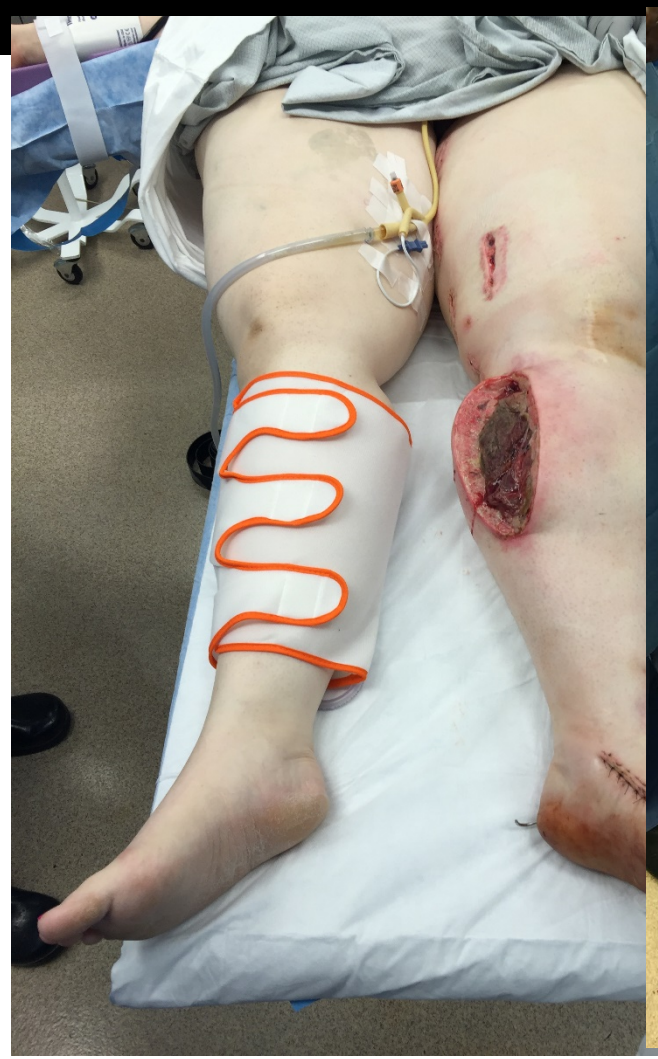
Higher likelihood of PCL tear

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!



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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

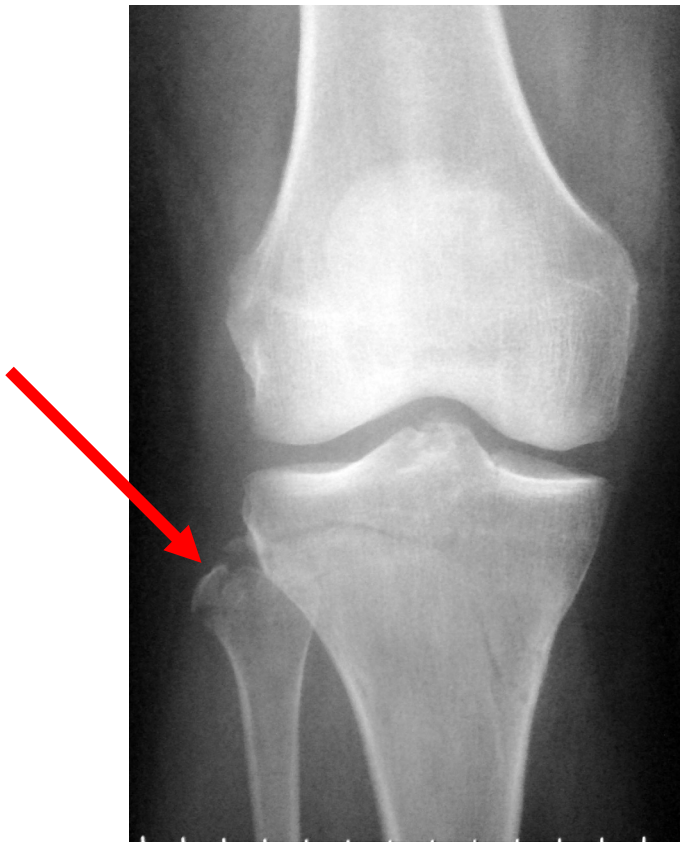
Pay attention to clinical signs: swelling, effusion, tenderness, instability

It is easy to overlook!

Knee Radiographs

It is easy to overlook!

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



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

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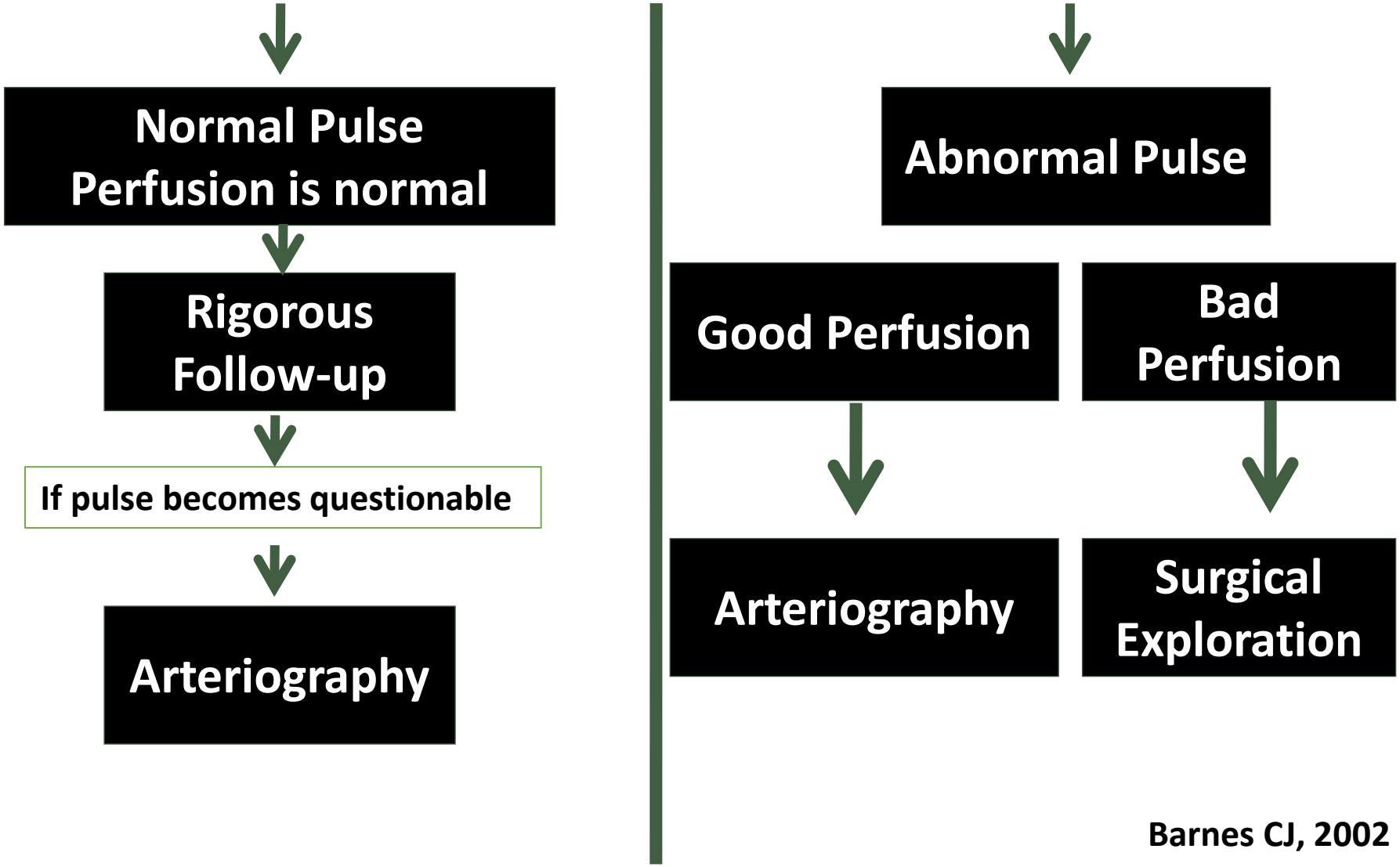
Repeated clinical assessment of the knee in the first 48 hours

Angiography only for cases with compromise of perfusion

After Knee Reduction



Barnes CJ, 2002 [5]

Vascular Assessment

Ankle Brachial Index

ABI = doppler systolic arterial pressure in injured limb (ankle) / doppler systolic arterial pressure in uninjured limb (brachial)

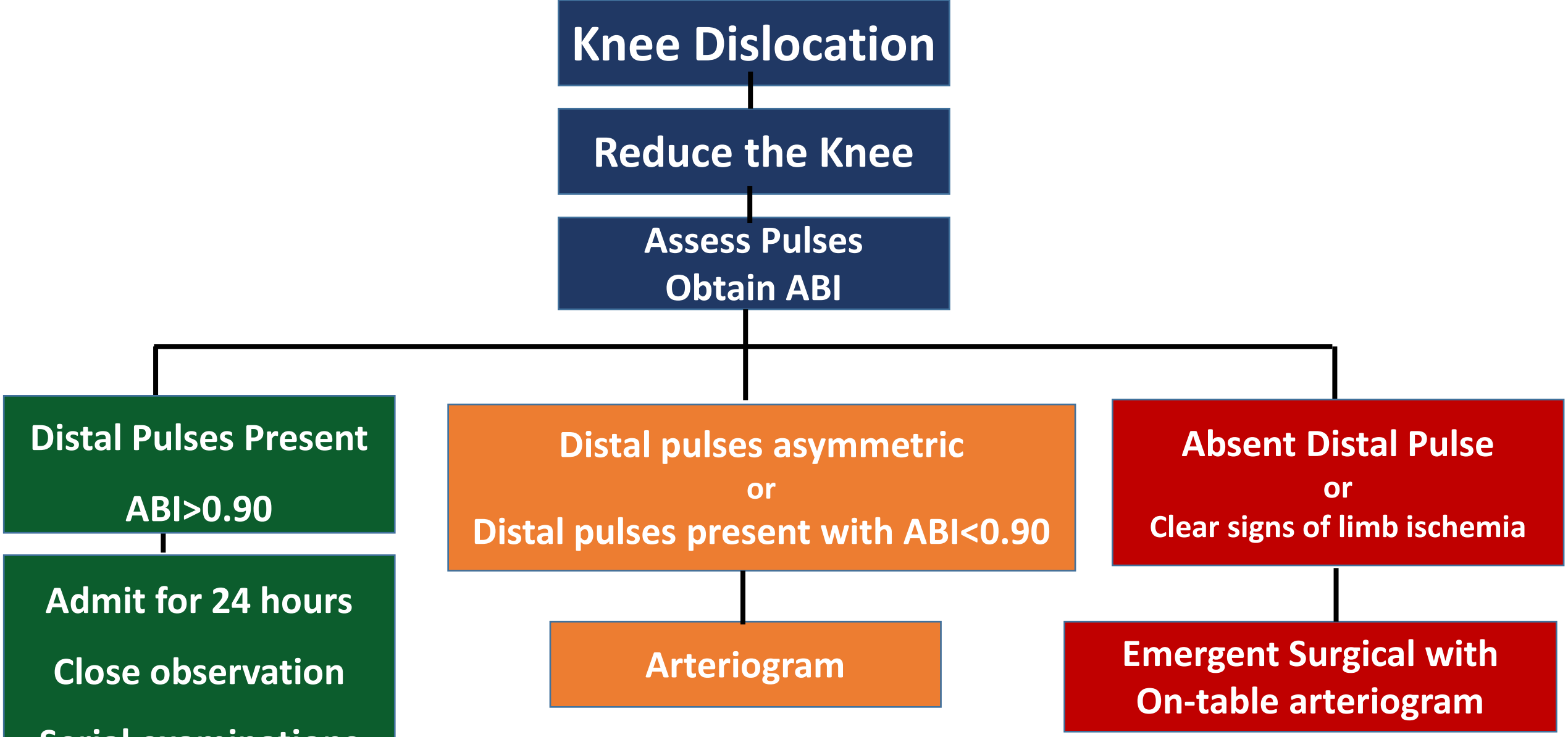
ABI < 0.90

Indication for CT angiography

Mills et al. 2004 [6]

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



Nicandri et al, 2009 [7]

Attention!!!

- **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**

Clin Orthop Relat Res (2014) 472:2621–2629
DOI 10.1007/s11999-014-3511-3

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SYMPOSIUM: MANAGEMENT OF THE DISLOCATED KNEE

Vascular and Nerve Injury After Knee Dislocation

A Systematic Review [8]

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.

Green NE, Allen BL. J Bone Joint Surg Am 1977;59:236–9. [9]

- ✓ 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 [10]

Treatment of Peroneal Nerve Injuries in the Multiligament Injured/Dislocated Knee

Michael P. O'Malley, MD[1] Ayoosh Pareek, BS[1] Patrick Reardon, BS[1] Aaron Krych, MD[1]
Michael J. Stuart, MD[1] Bruce A. Levy, MD[1]

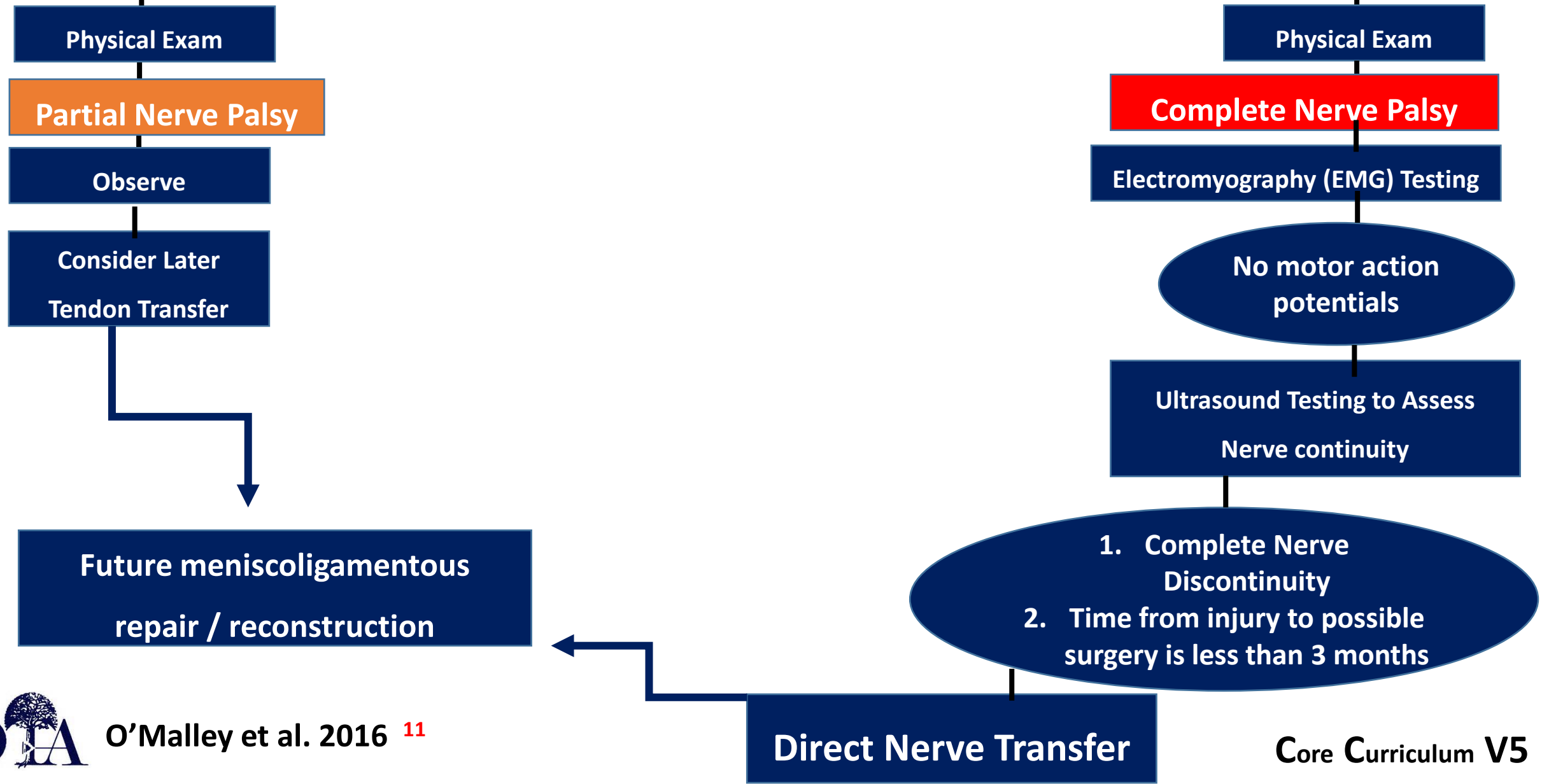
[1] Department of Orthopedic Surgery, Mayo Clinic, Rochester, Minnesota

Address for correspondence Bruce A. Levy, MD, Orthopedic Surgery, Mayo Clinic, 200 1st St. SW, Rochester, MN 55905 (e-mail: levy.bruce@mayo.edu).

J Knee Surg 2016;29:287–292. 11

Differentiate between complete and incomplete nerve palsy determines the prognosis

Peroneal Nerve Injury in the Setting of Knee Dislocations



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

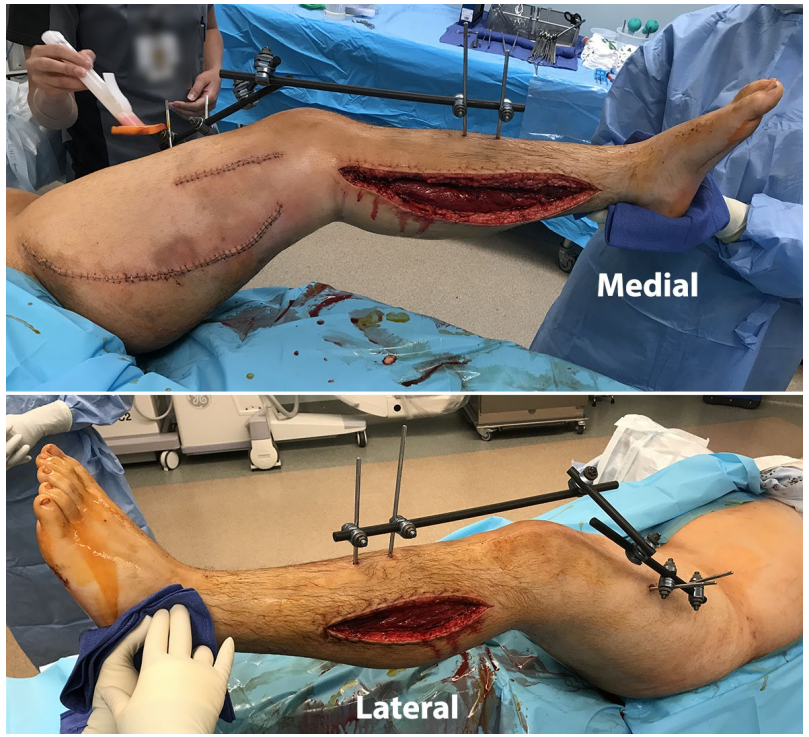
- Urgent reduction of the knee at the ER
- Immediate neurovascular assessment (before and after reduction)
- Urgent surgical management = open fractures
  - Irrigation and Debridement
  - Provisional stabilization: spanning fixator
  - Image studies: radiographs/**MRI**

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

Anterior

Posterior

Medial

Lateral

Rotatory (Combination)

It is not applicable if the knee is reduced at patient's admission.

Up to 80% of the knee dislocations reduce spontaneously before patient's admission.

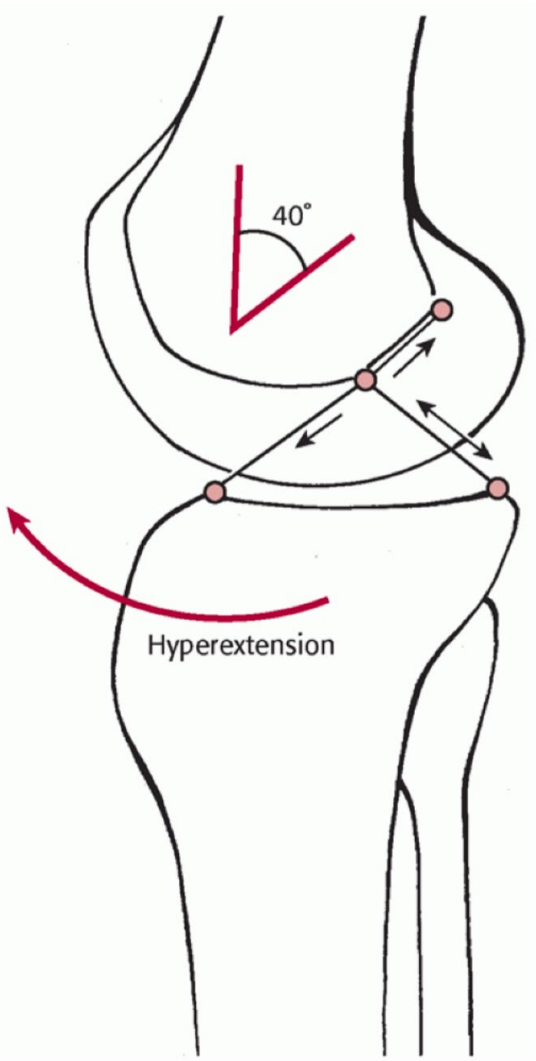
It does not describe which structures have been torn

Kennedy et al, JBJS 1963 [12]

Anterior Knee Dislocation

50% of all knee dislocations

If Hyperextension > 50 degrees…



Popliteal Artery Tear

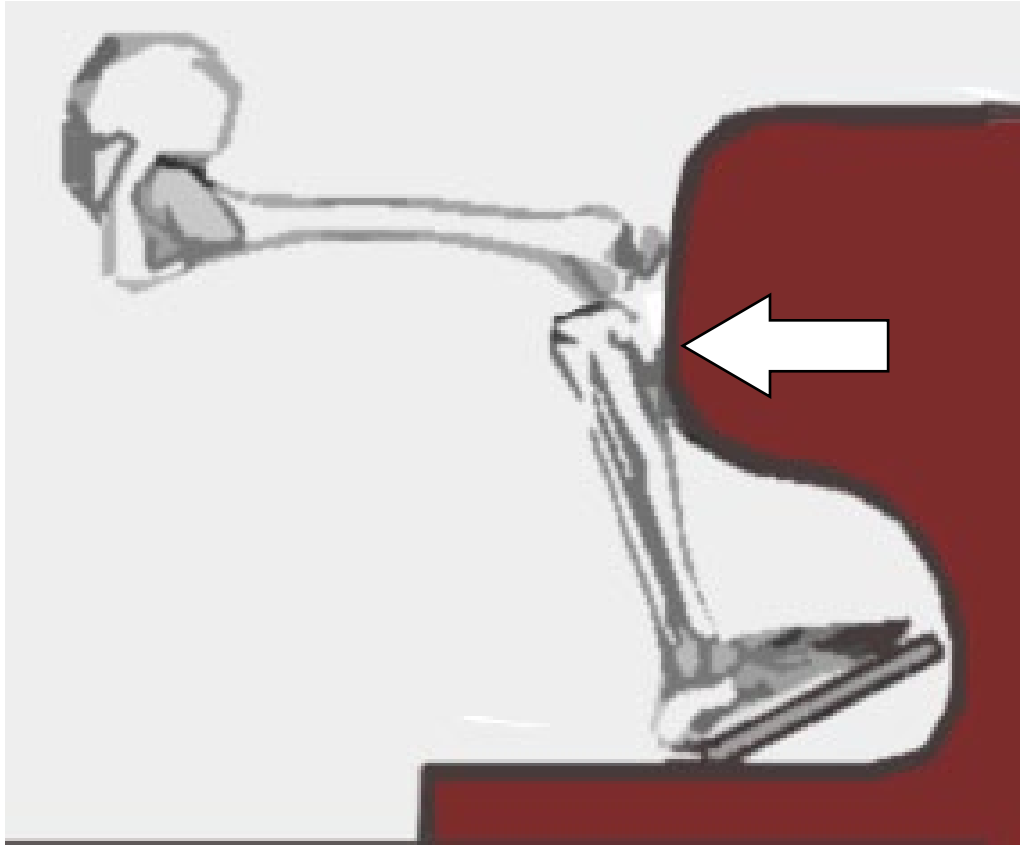
Posterior Knee Dislocation

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 [12]

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]

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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**

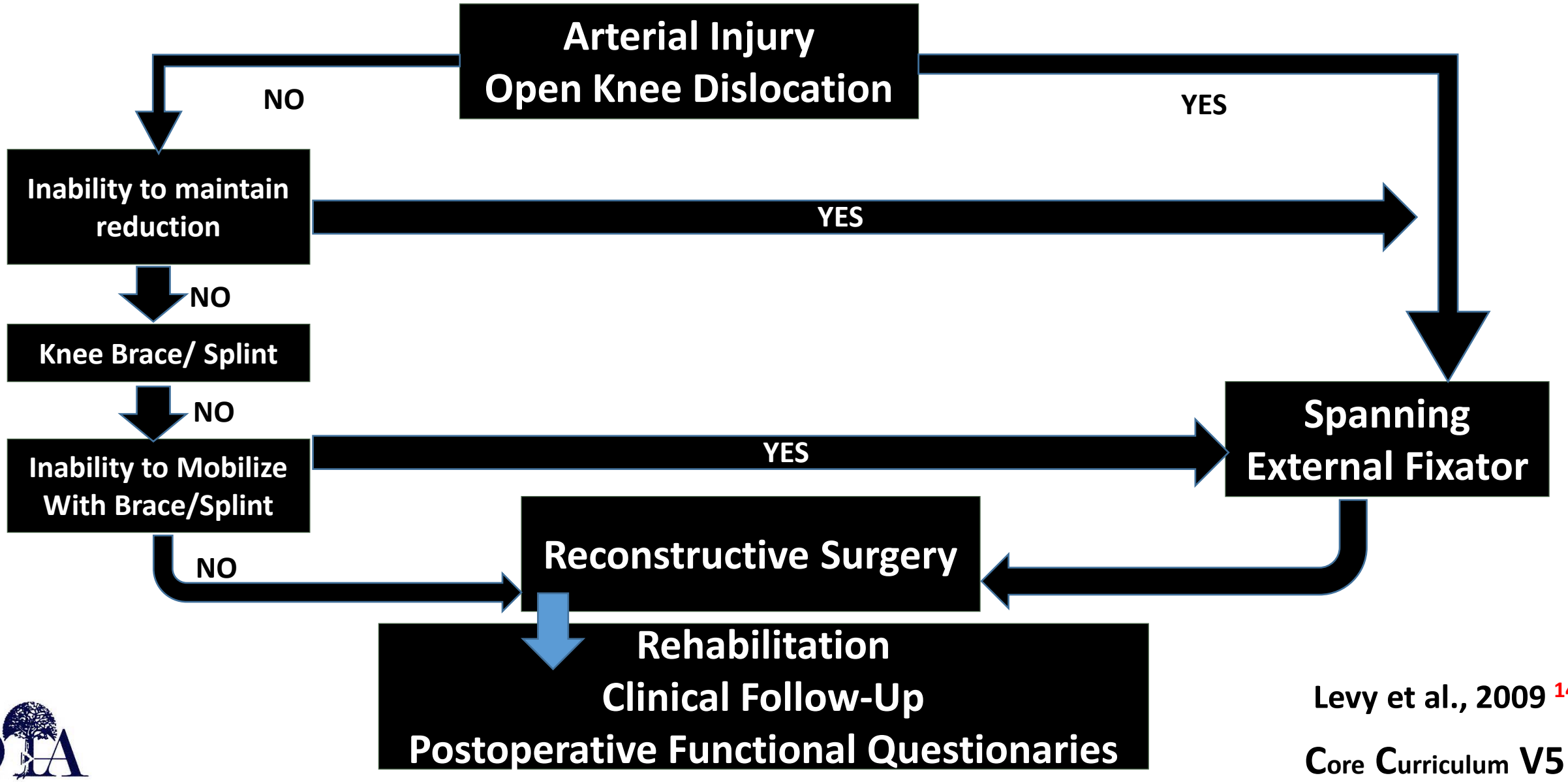
Closed reduction of knee dislocations

- **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.**

Multiligament Knee Injury



Levy et al., 2009 [14]

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

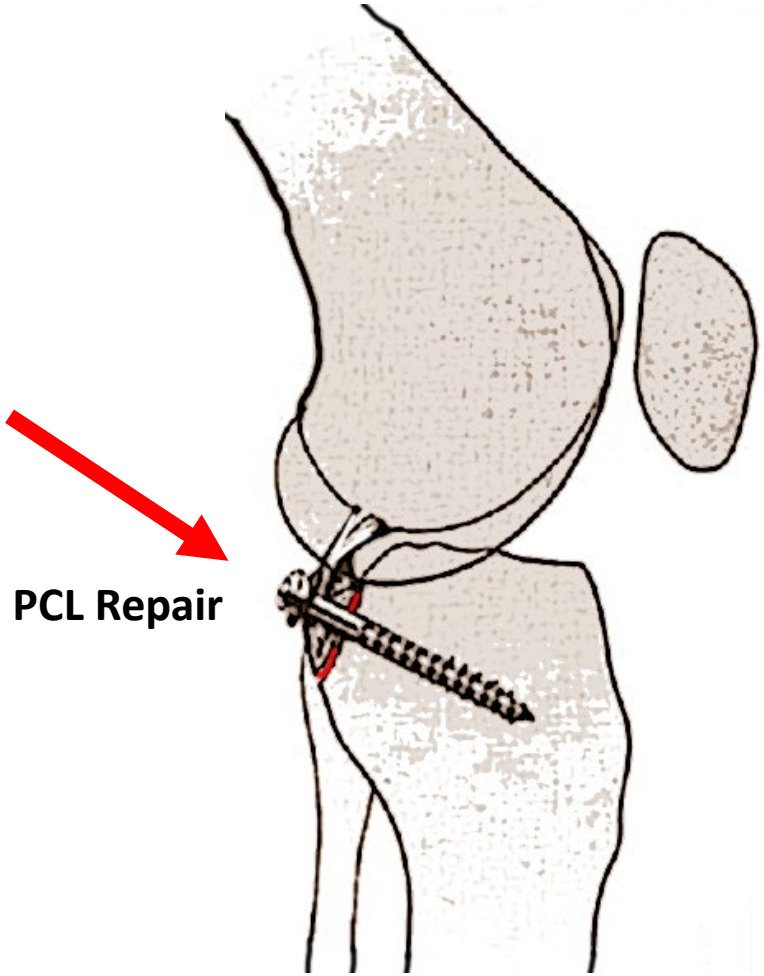
- In case there is documented DVT
  - A consideration should be given to an inferior vena cava filter placement with chemical anticoagulation

Collins et al, 1992 [15] ; Sems et al, 2009 [16] ; Levy et al., 2010 [14]

Ligament Repair versus Reconstruction
Bone avulsions: Repair

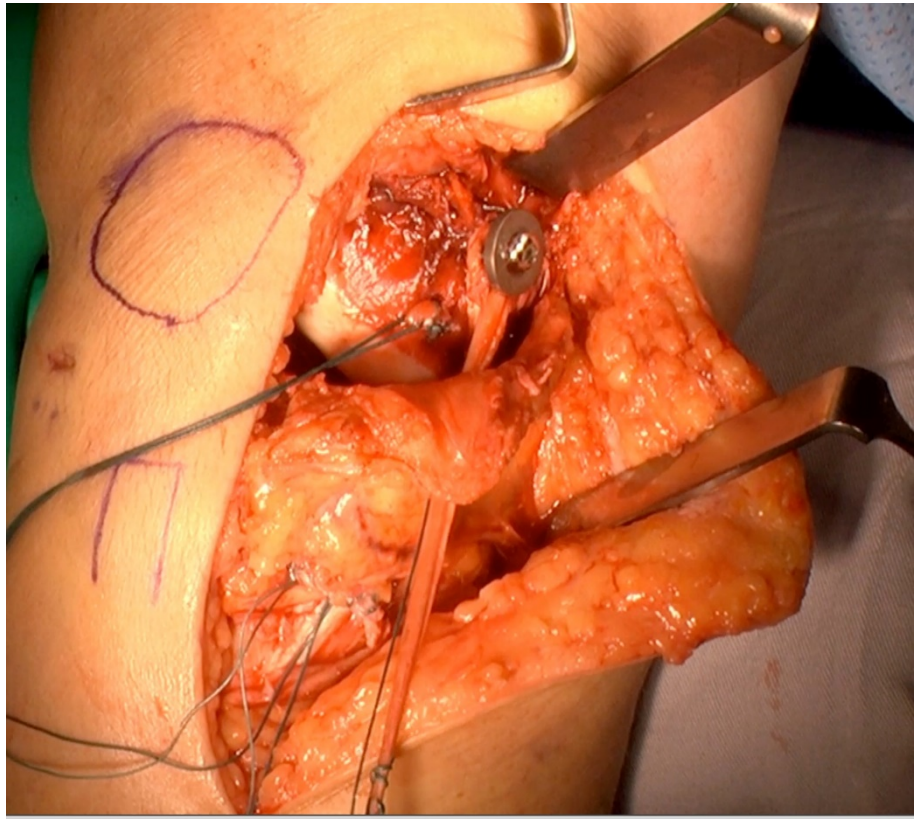
PCL Avulsion

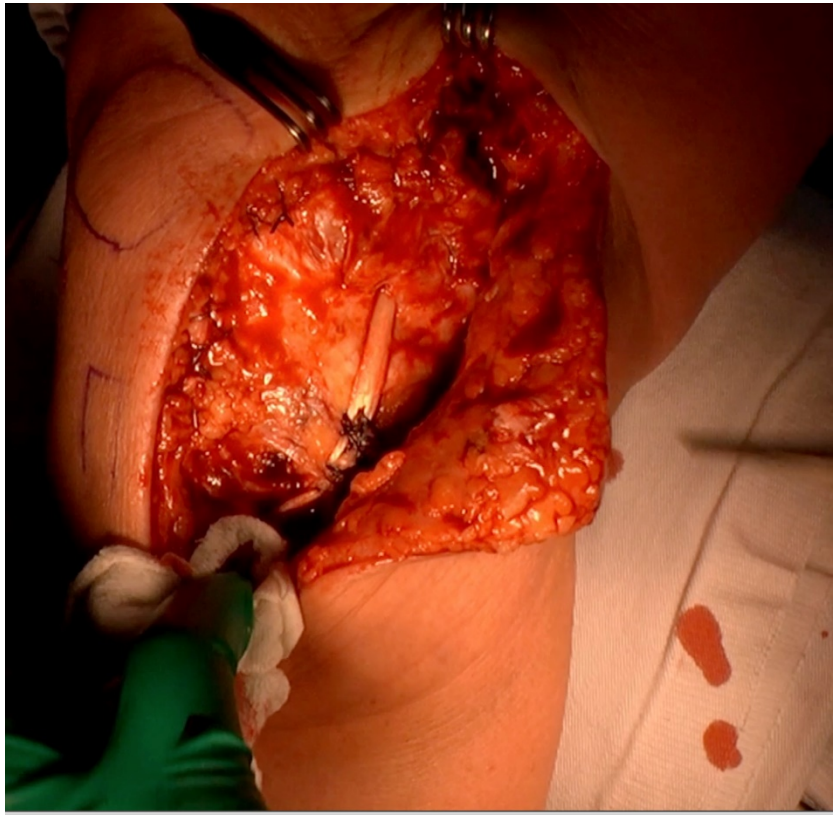
PCL Repair



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 [17]
From the Department of Surgery, Orthopaedic Division, University of Alabama at Birmingham, Birmingham, Alabama

Am J Sports Med: 33 (6), 2005

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

18
Am J Sports Med: 38 (4), 2010

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.

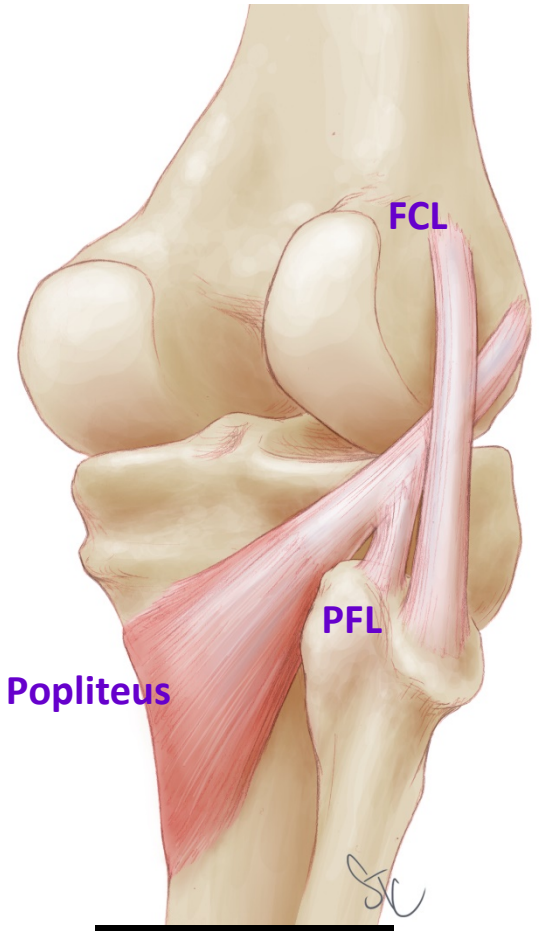
Posterolateral Instability: When should you repair?

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

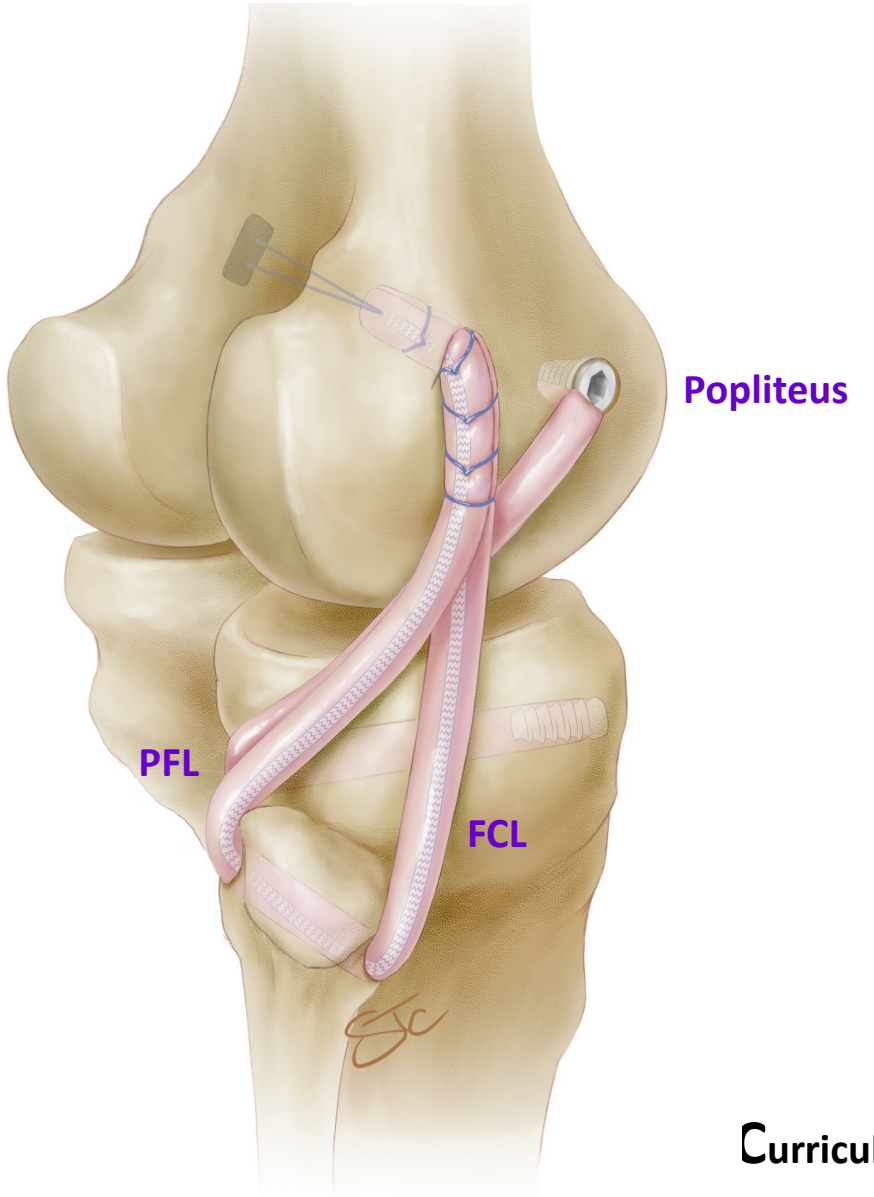


3 Key Structures:

Fibular Collateral Ligament

Popliteofibular Ligament

Popliteus Tendon



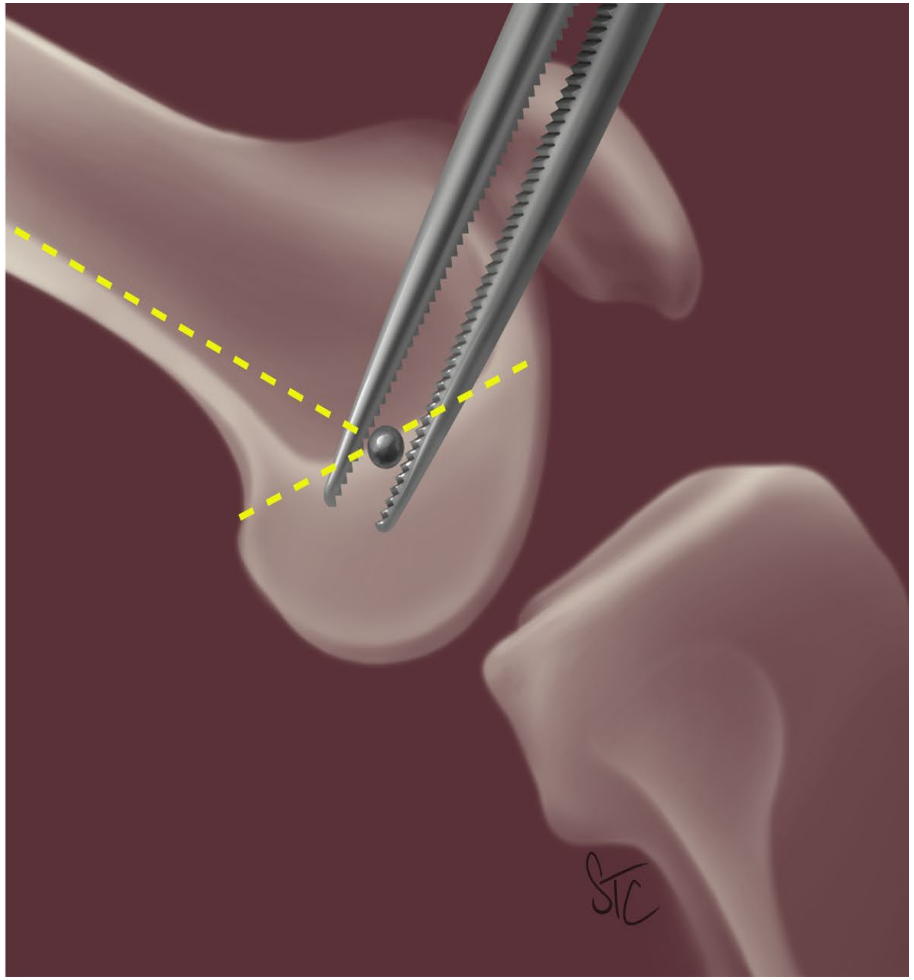
Isometric versus Anatomic

- 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

Stannard et al, Determining the isometric point of the knee: a comparison of the radiographic and anatomic techniques. J Knee Surg 2012 Mar 25(1): 71-4 [19]

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

> **4mm** using the anatomic method

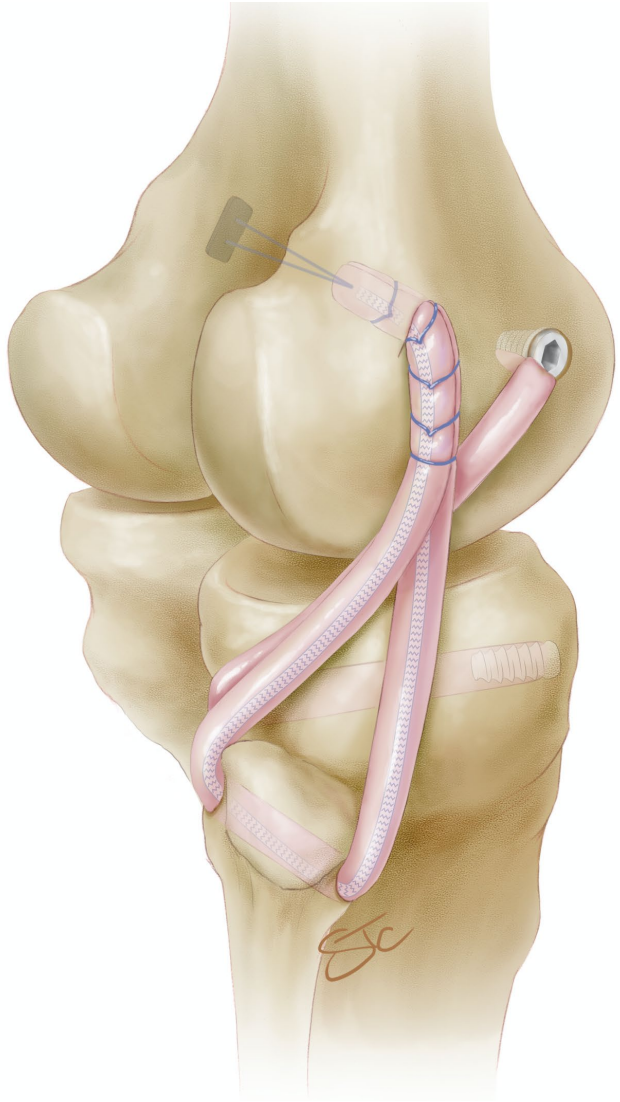
- One knee (**5%**) had excursion

> **4mm** using the radiographic method

Knee #	Anatomy	Fluoro
1	6	1
2	7	3
3	3	3
4	9	5
5	12	2
6	6	1
7	6	1
8	2	2
9	7	0
11	9	1
12	1	1
13	2	1
14	4	2
15	4	4
16	4	2
17	1	1
18	3	0
19	5	1
20	1	0
Median	4	1
Mean	4.84	1.63
Std. Dev.	3.06	1.34
P Value	0.00018	

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]



Biomechanical Comparison of Five Posterior Cruciate Ligament Reconstruction Techniques

Clayton W. Nuelle, MD[1,2] Jeffrey L. Milles, MD[1] Ferris M. Pfeiffer, PhD[1,2] James P. Stannard, MD[1,2]
Patrick A. Smith, MD[1,3] Mauricio Kfuri Jr., MD, PhD[1,2] James L. Cook, DVM, PhD[1,2]

[1] Department of Orthopaedic Surgery, University of Missouri, Columbia, Missouri
[2] Thompson Laboratory for Regenerative Orthopaedics, University of Missouri, Columbia, Missouri
[3] Columbia Orthopaedic Group, Columbia, Missouri

Address for correspondence Clayton W. Nuelle, MD, Department of Orthopaedic Surgery, Missouri Orthopaedic Institute, University of Missouri, 1100 Virginia Avenue, DC 953.00, Columbia, MO 65212 (e-mail: nuellec@health.missouri.edu).

J Knee Surg 2017;30:523–531. 21

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.

J Bone Joint Surg Am. 2014;96:184-91 [22]

Hinged External Fixation in the Treatment of Knee Dislocations

A Prospective Randomized Study

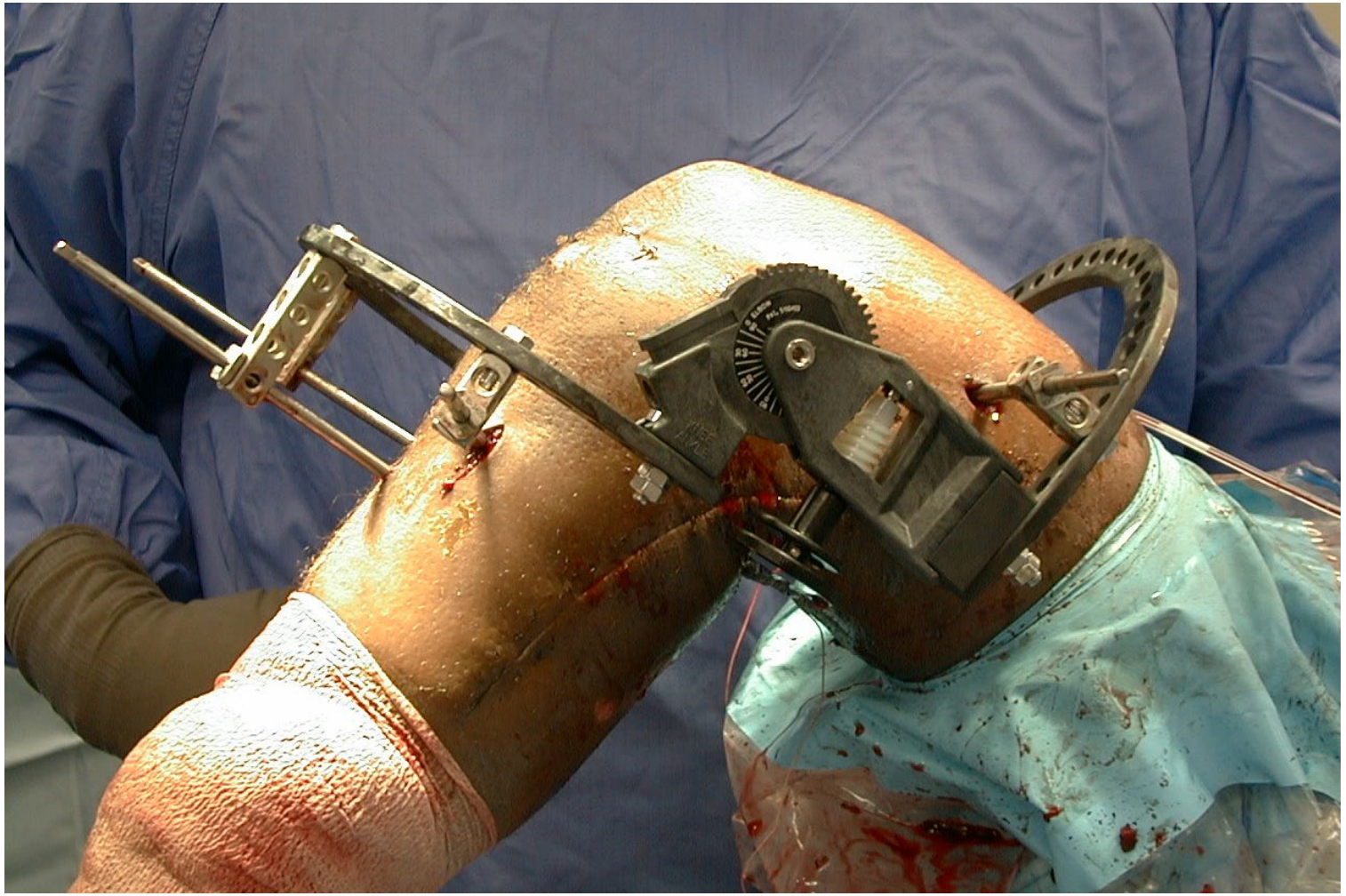
James P. Stannard, MD, Clayton W. Nuelle, MD, Gerald McGwin, PhD, and David A. Volgas, MD

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

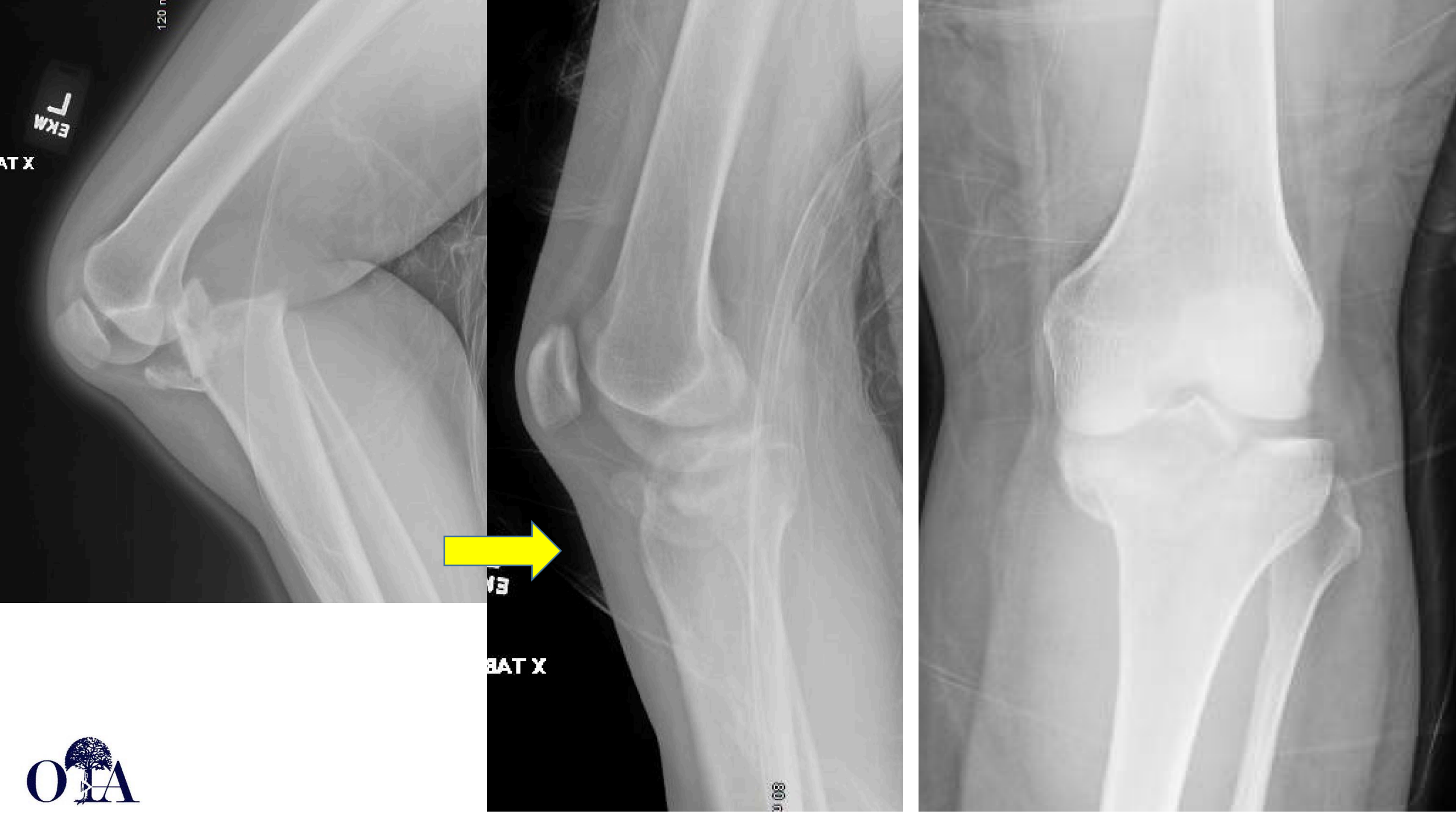
- **Acute Repair/Reconstruction – Performed within the first three weeks of the injury – when tissues are still identifiable without significant scarring;**
- **Staged Repair/Reconstruction – Consists in repairing/reconstructing the peripheral ligaments followed by delayed cruciate ligament reconstructions 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)**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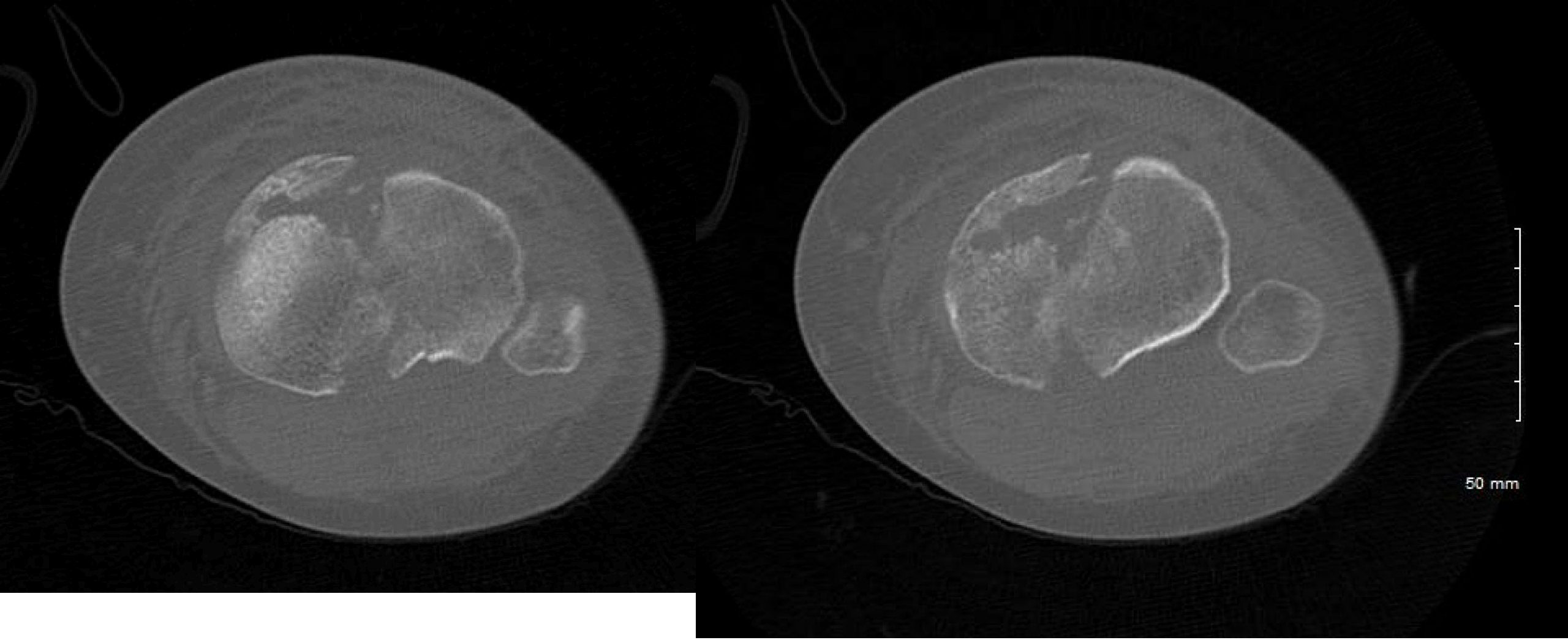
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Injury, Int. J. Care Injured 49 (2018) 2252–2263

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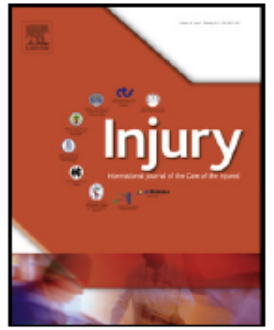

Revisiting the Schatzker classification of tibial plateau fractures

Mauricio Kfuri[a,b,*], Joseph Schatzker[c]

[a] Department of Orthopedics, University of Missouri, Columbia, MO, United States
[b] Department of Biomechanics, Medicine and Rehabilitation of the Locomotor System, School of Medicine of Ribeirão Preto, University of São Paulo, Ribeirão Preto, Brazil
[c] Division of Orthopedics, Sunnybrook Health Sciences Center, University of Toronto, Ontario, Canada

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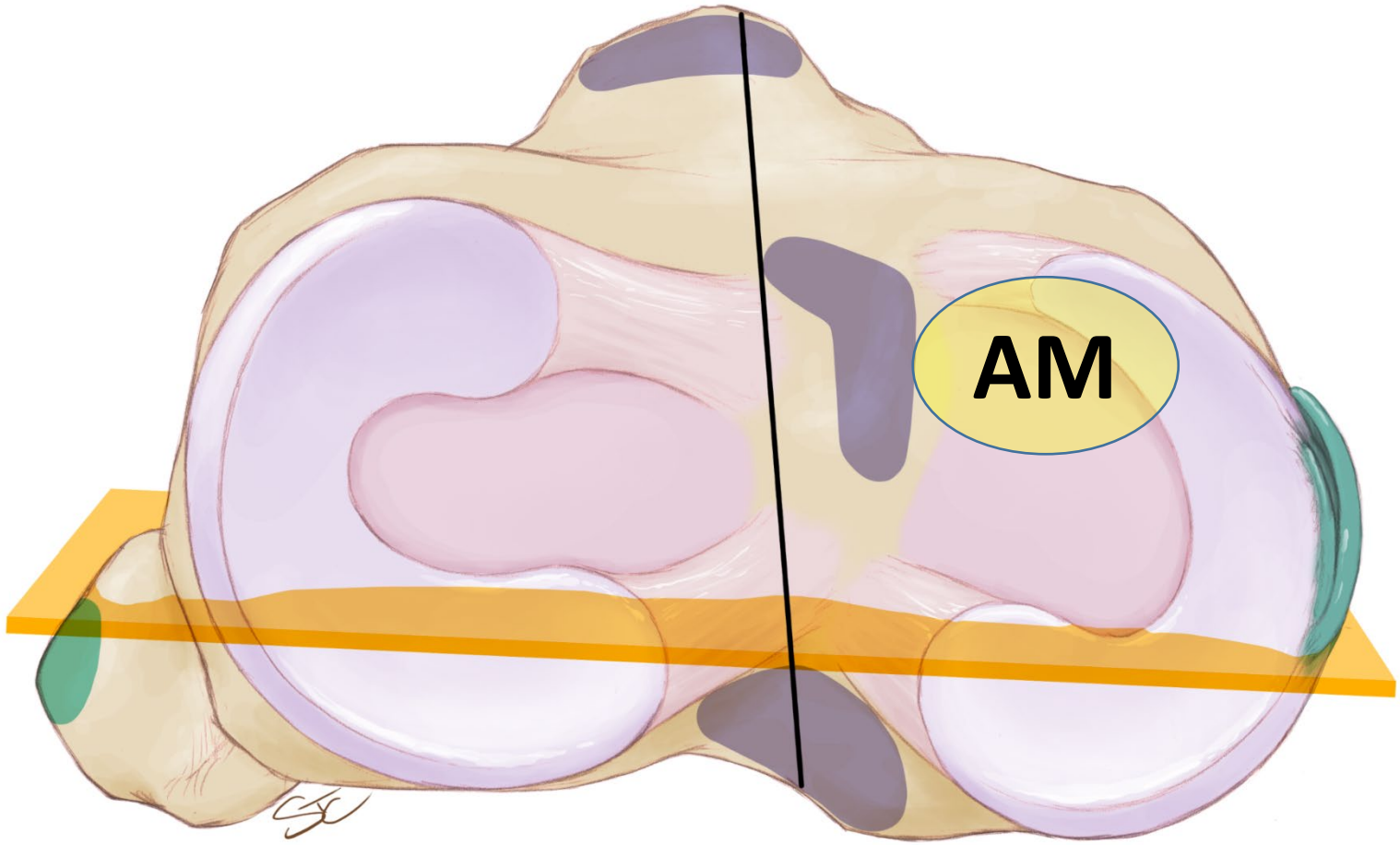
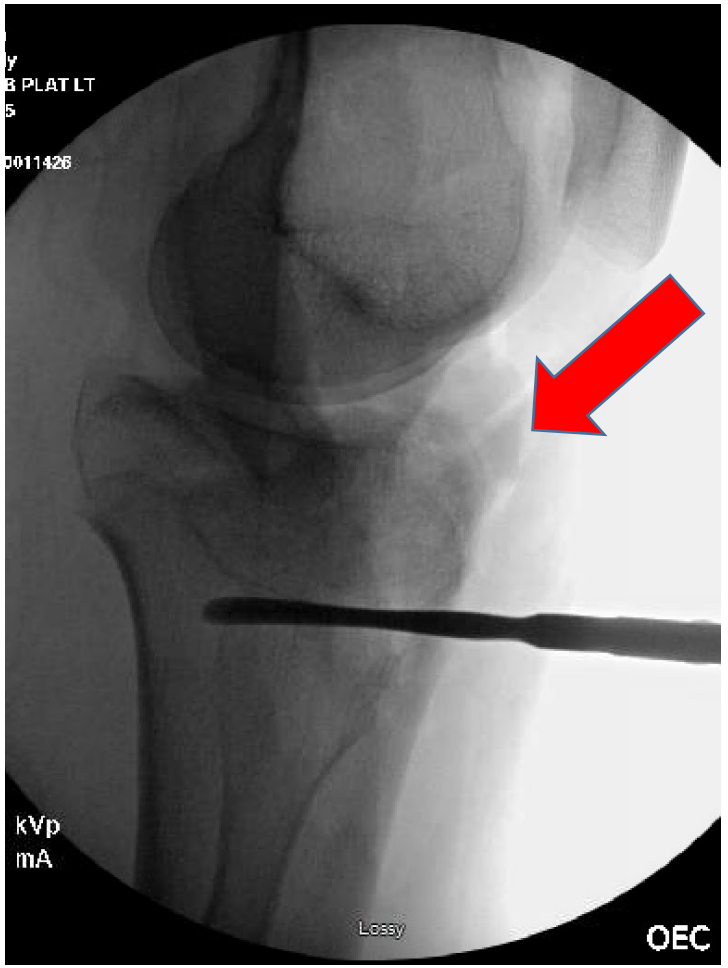
Type IV A



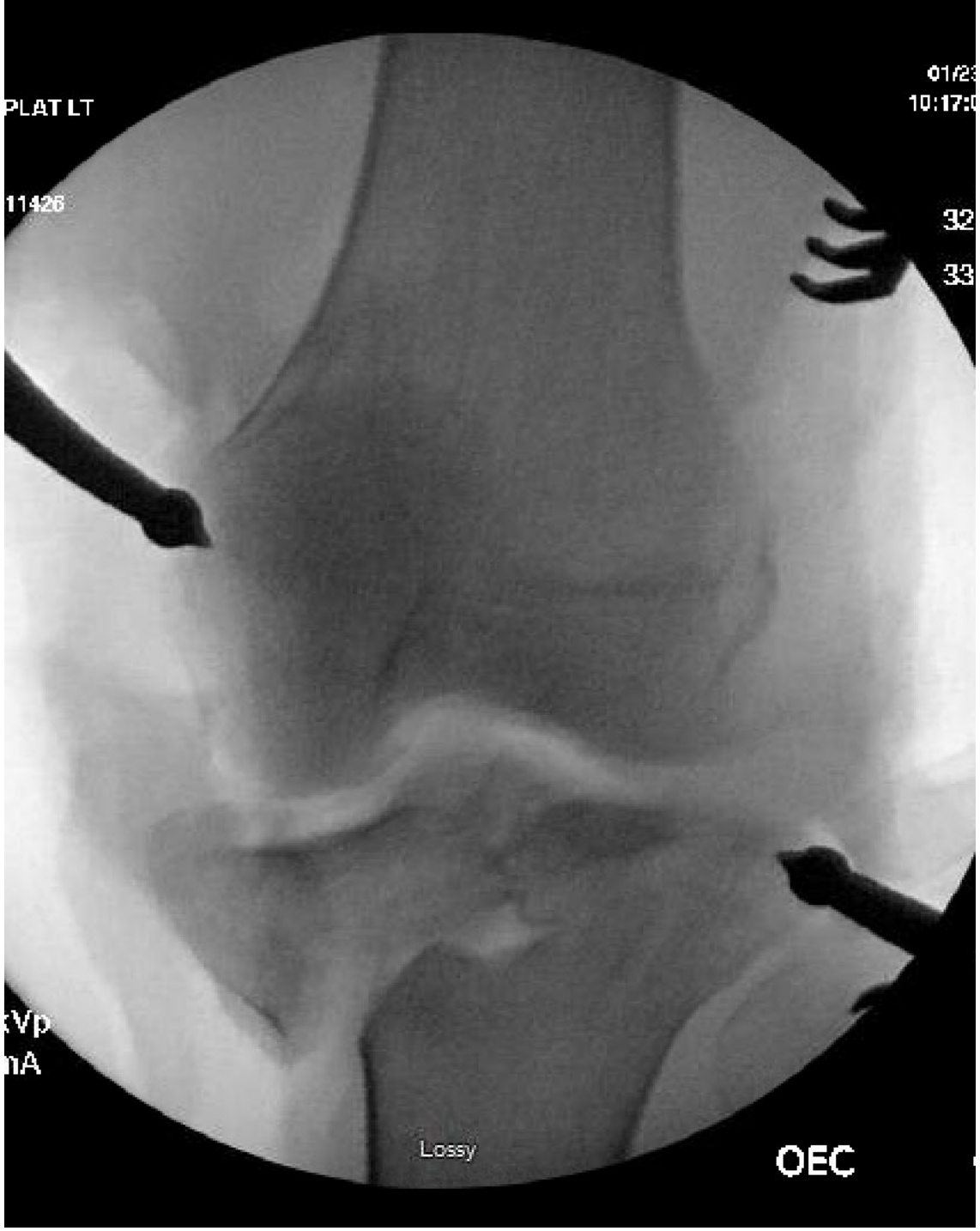
Kfuri and Schatzker Core Curriculum V5

Posterolateral Corner Injury

Fracture dislocation: widened tibial plateau
Lateral translation of the tibia
Instability = Lack of containment



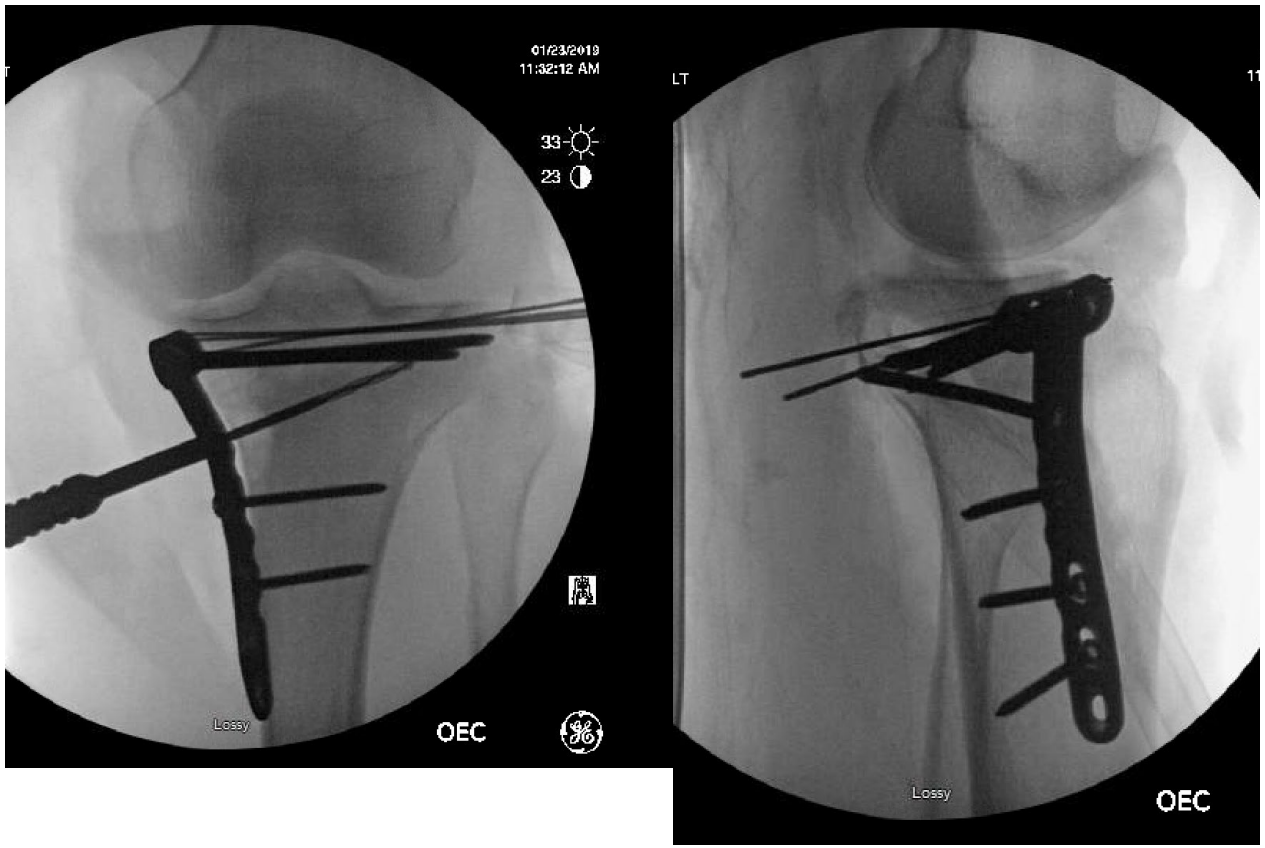
Compromise of the anteromedial tibial rim
Instability = Lack of containment



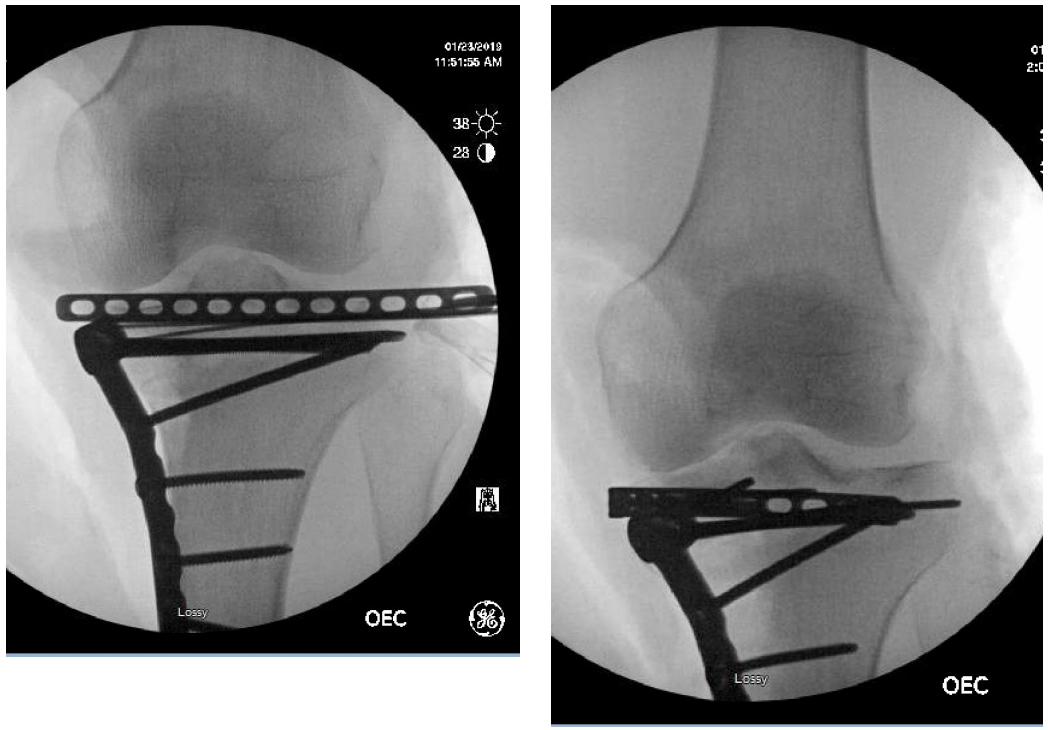
Reducing the tibial subluxation

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

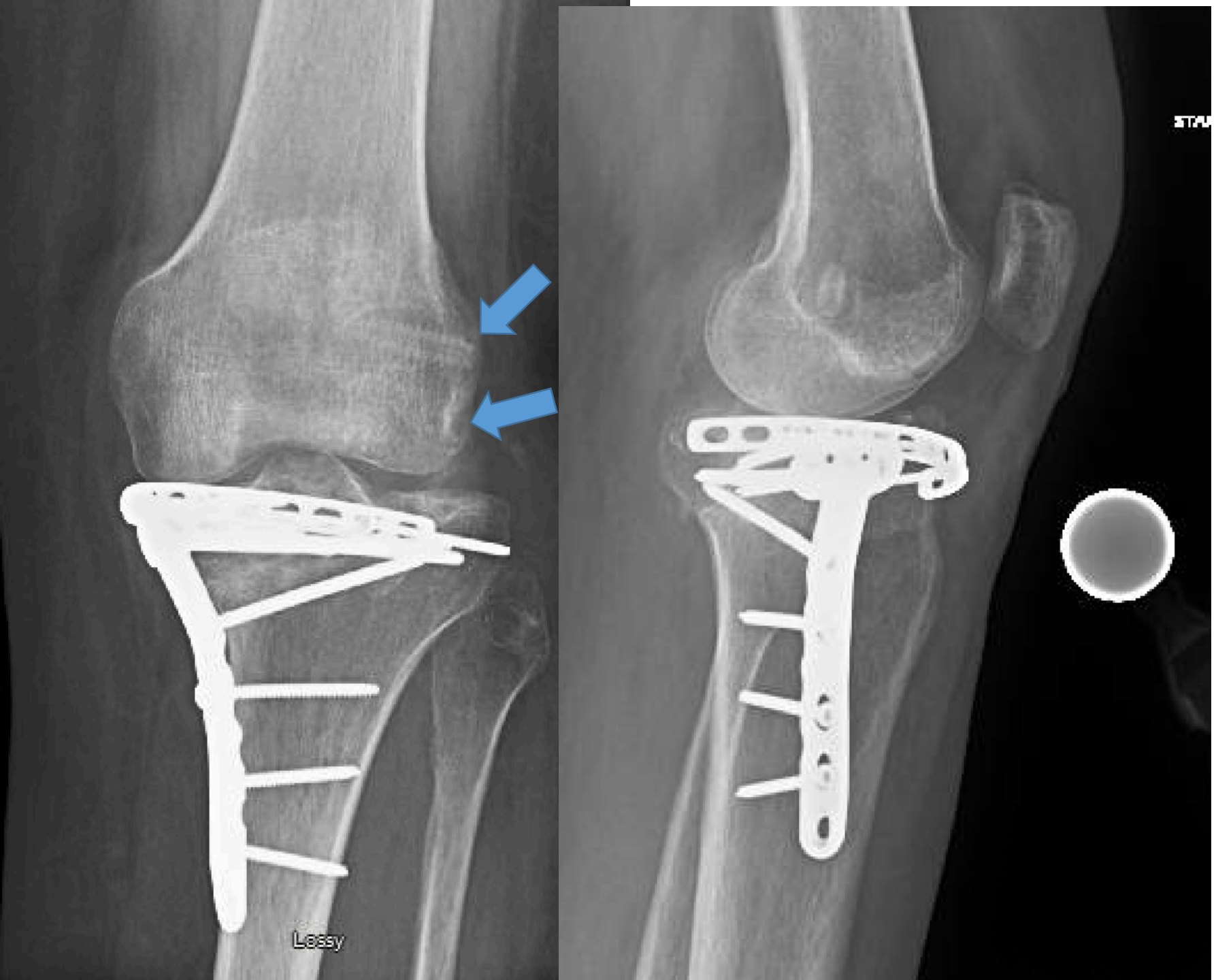
Restoring the Tibial Containment



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 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)

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Thank you!

University of Missouri, Columbia