

Tibial Plateau Fractures, Tibial Shaft Fractures, and Knee Dislocations



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CONFLICTS

- No conflicts regarding this discussion



Acknowledgements

OTA Resident Core Curriculum lectures made by the Orthopaedic Trauma Association for Education were used as the foundation of this presentation.

I wish to acknowledge all of the many OTA Authors' work that prepared me today.

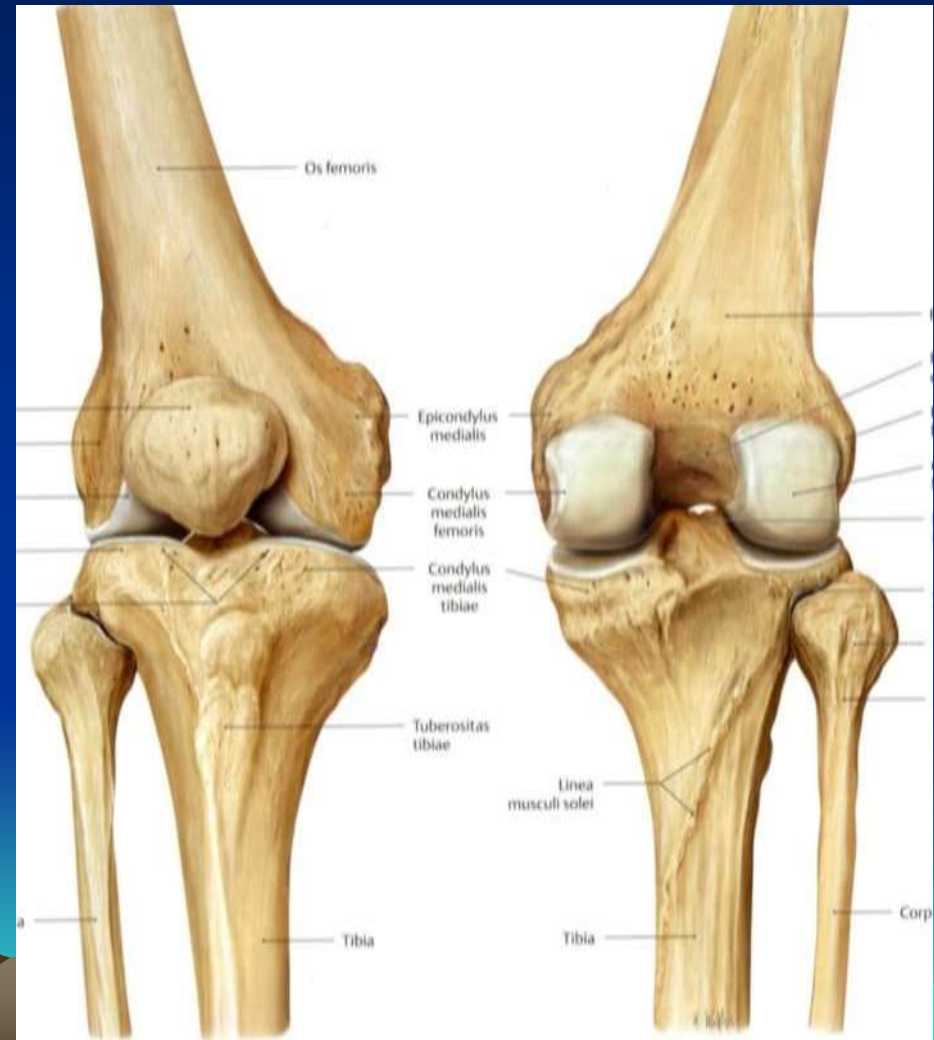
At the end of this session,
participants will be able to:

- Identify common pitfalls with knee dislocations and fractures of the proximal tibia and shaft.
- Identify injury patterns, physical exam techniques/evaluation, and care.
- Explain imaging modalities and some of their limitations.



Anatomy: Tibiofemoral Joint

- Bones
 - femoral condyles
 - tibial plateau
- Dissimilar surfaces
- Little/No inherent bony stability
- May be cause of additional instability if fractured



Anatomy of the Tibial Plateau

- Proximal Tibia

- Medial and lateral plateau or condyles

- Medial Plateau-Concave
 - Lateral Plateau-Convex

- Bony prominences (attachments)

- Intercondylar eminence (ACL)
 - Tibial tubercle (Patellar Tendon)
 - Gerdy' s tubercle (ITB)

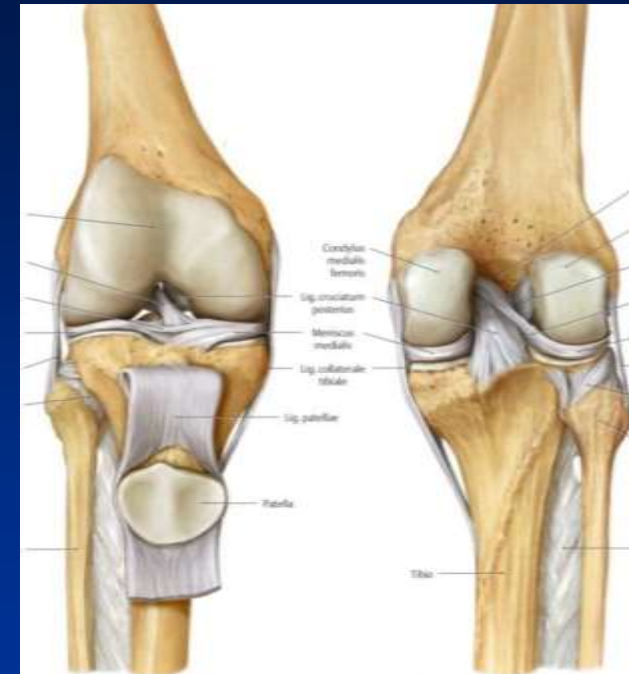
- Joints

- Knee joint (Distal Femur/Patella)
 - Proximal tib/fib joint



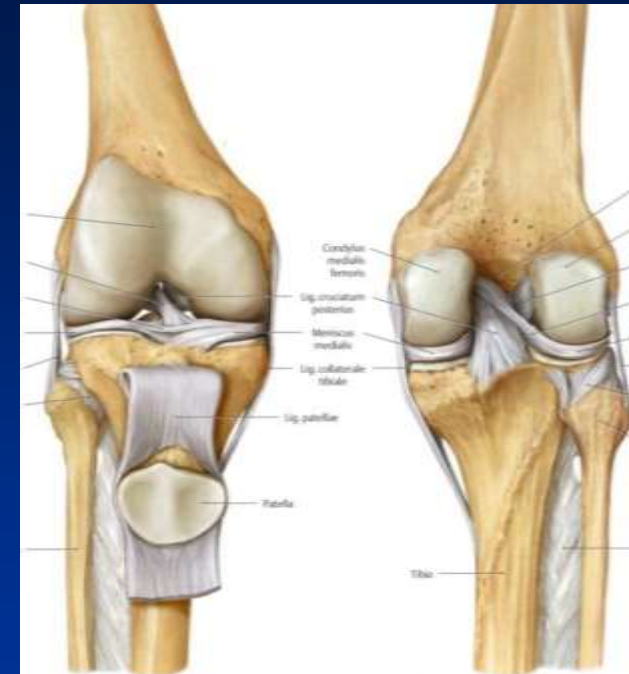
Stabilizers of the Tibiofemoral Joint

- Soft tissues: stabilize while allowing ROM
 - Ligaments
 - Joint capsule
 - Menisci
 - Musculotendinous units (DYNAMIC)



Ligament Stabilizer Anatomy

- ACL
- PCL
- MCL, posteromedial capsule
- LCL & PLC (popliteofibular ligament, popliteus, capsule, ITB, biceps femoris)



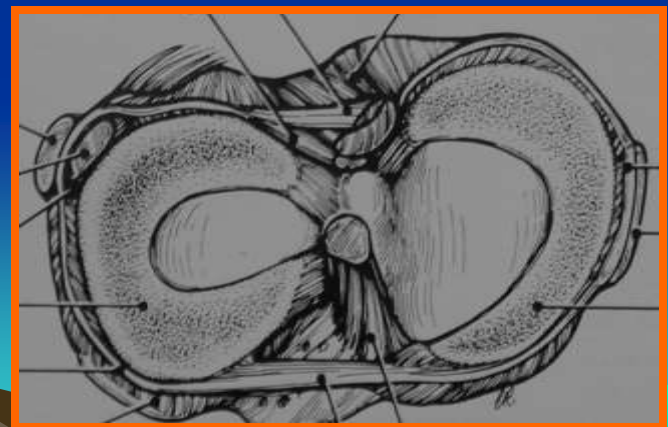
Meniscus

- Lateral meniscus

- More circular than medial
- Covers more of articular surface than medial
- Attached to PCL via ligaments
 - Humphry (anterior)
 - Wrisberg (posterior)
- No attachment to LCL
- Bears more joint reactive force

- Medial meniscus

- “C” shaped
- intimately attached to MCL
- bears equal joint reactive force as bone



Vascular Anatomy

- Popliteal artery at risk for being tethered
 - Adductor hiatus
 - Soleus arch
- If blood flow through popliteal artery disrupted
Inadequate blood supply

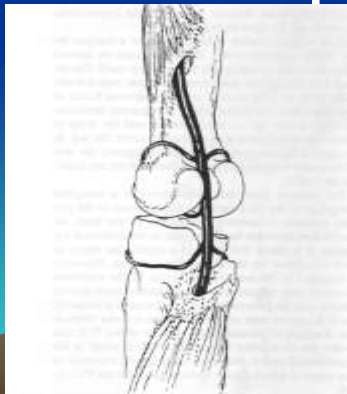
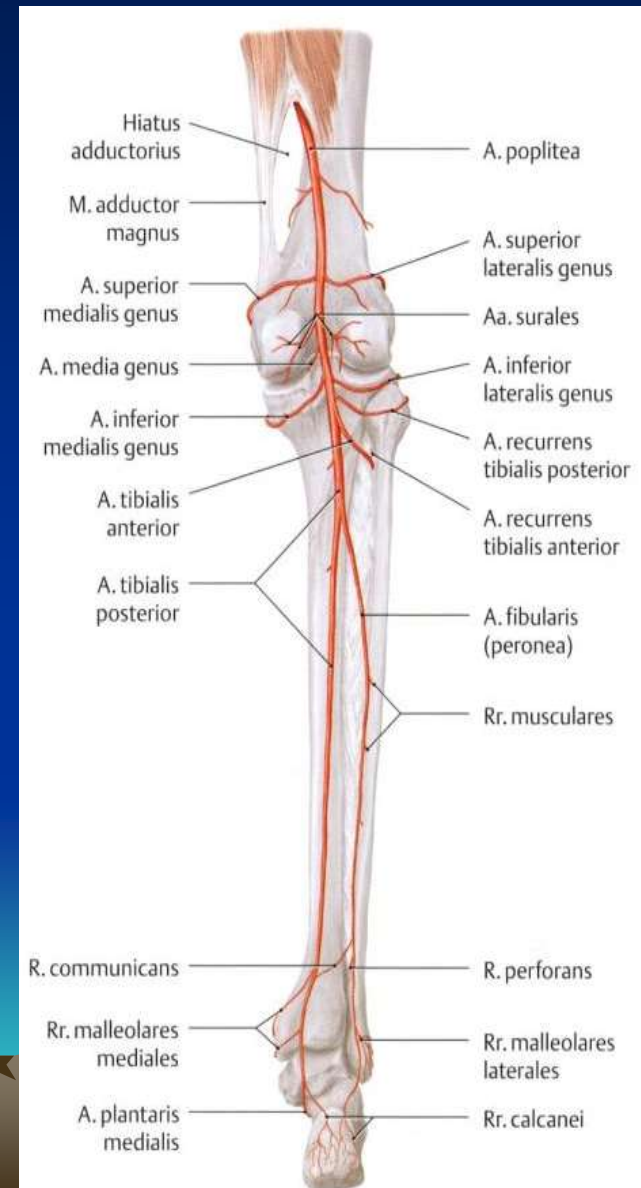
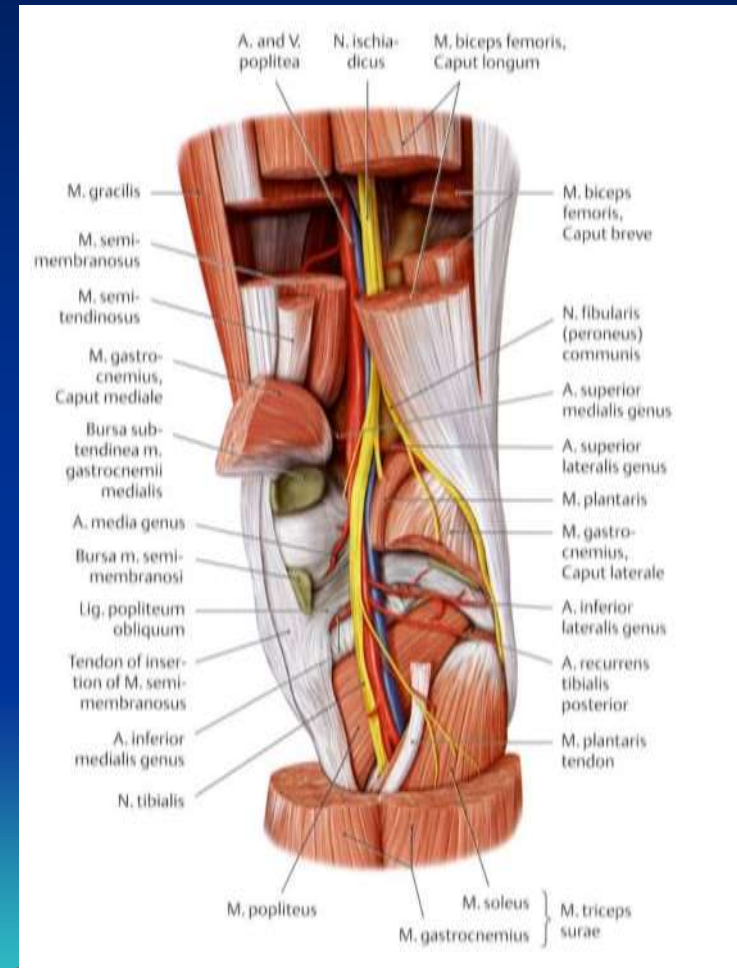


Figure 41.1. Anatomy of the popliteal artery posterior to the knee joint. (From Chapman: Atlas Operative orthopaedics, Philadelphia, JB Lippincott, 1998)



Anatomy: Nerves

- Influencers Long Term Outcome
 - Peroneal nerve
 - More commonly injured
 - Tethered around the fibular neck
 - Mechanism of injury
 - Tension (Varus \pm hyperextension, Translation (Anterior /Posterior dislocation))
 - Direct impact
 - Iatrogenic (varus/hyperextension during aggressive EUA (!))
 - Tibial nerve



Dislocation Epidemiology

- True incidence is underreported
 - Spontaneous reduction
 - Definition (documented complete dislocation vs. ≥ 1 cruciate + one collateral injury)
 - Obesity interferes with exam and mechanism
- Presented in a variety of clinical practices
 - Trauma Center
 - Sport Medicine
 - General Orthopaedics



BEWARE OF THE TIBIAL PLATEAU FRACTURE, ESPECIALLY PEDIATRIC, CAUSED BY UNRECOGNIZED DISLOCATION

Dislocation Epidemiology

- 0.2 % of all orthopaedic injuries
- Young ♂
- MVA, sports trauma
- 14-44 % associated w multiple trauma
- Bilateral 5 %



Tibial Plateau Demographics

- 1% of all fractures
- 8% of all fractures in the elderly
- Lateral plateau involved 55-70%
- Medial plateau involved 10-20%
- Both involved 10-30%



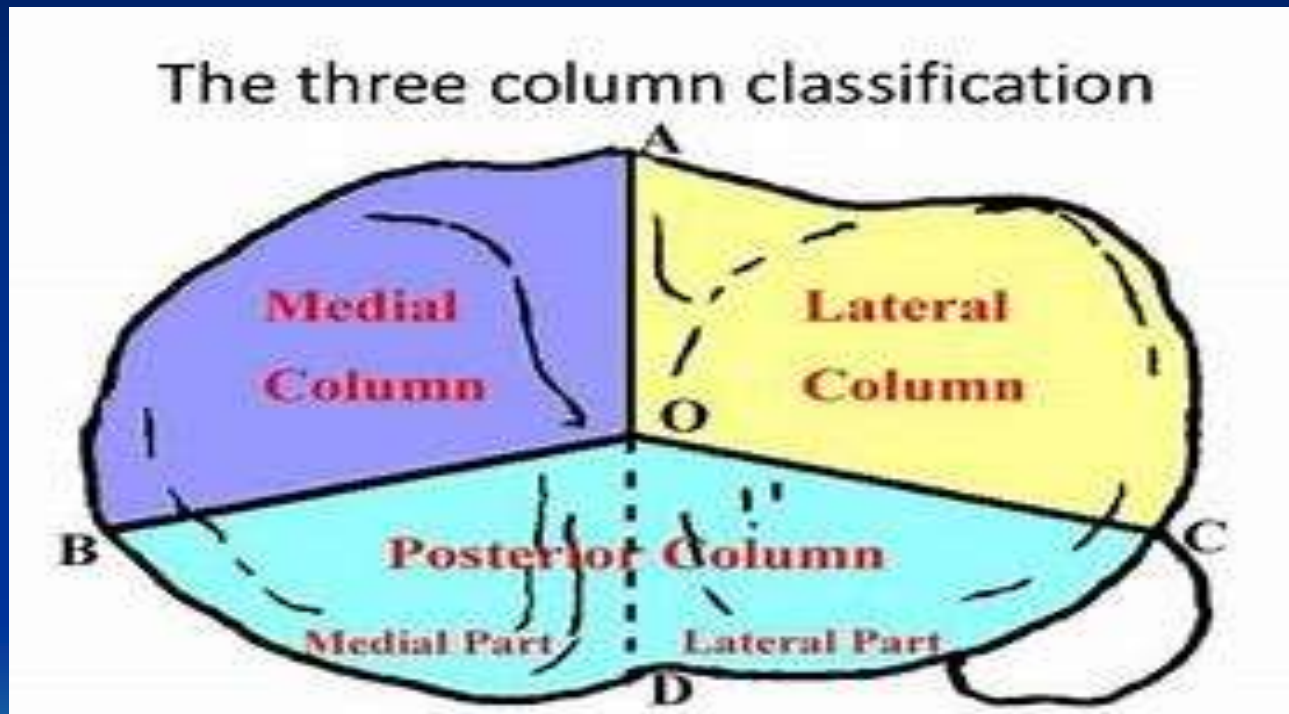
Plateau Classification

Schatzker, Clin Orthop, 1979

- Type I - Split Lateral Tibial Plateau Fx
- Type II - Split/Depression Lateral Plateau Fx
- Type III - Pure Depression Lateral Plateau Fx
- Type IV - Medial Tibial Plateau Fx (Fx Disloca)
- Type V - Bicondylar Split Fx
- Type VI - Tibial Plateau Fx with Metaphyseal - Diaphyseal Separation



Current Discussion on 3 Columns of Plateau Fractures



Tibia Fractures

- Most common long bone fracture
- 492,000 fractures yearly
- 100,000 non-unions per year
- Open fractures of the tibia are more common than in any other long bone



Tibia History & Physical

- Low Energy
 - Minimal soft-tissue injury
 - Less complicated fracture pattern and management decisions
- High Energy
 - High incidence of neurovascular energy and open injury
 - Low threshold for compartment syndrome
 - Complete soft-tissue injury may not declare itself for several days



Tibial Fracture

Associated Injuries

30% of patients will have multiple injuries

- Ipsilateral Fibula Fracture
- Foot & Ankle injury
- Syndesmotic Injury
- Ligamentous knee injuries

-Ipsilateral Femur Fx
“Floating Knee”

-Neurovascular Injury
More Common In:

High Energy
Proximal Fracture
Floating Knee
Knee Dislocation



Tibial Shaft Classification

- Numerous systems
 - Use Clear Simple Description
- Important variables
 - Fracture Pattern
 - Location
 - Comminution
 - Associated Fibula Fx
 - Degree of soft-tissue injury



Knee/Plateau/Tibia Physical Exam

- Neurologic and vascular exam of extremity including ABI's if indicated Johansen K, *J Trauma* April 1991
- Wounds should be assessed once in ER, then covered with sterile gauze dressing until treated in OR- **digital camera / cell phone**
- True classification of wound best done after surgical debridement completed



Dislocation Indicators

If any of the following present r/o Multiligamentous injury
(Spontaneous reduction UNDERDIAGNOSED)

- Hyperextension
- Popliteal ecchymosis
- Vascular insufficiency
- Peroneal nerve deficit
- Diffuse tenderness but
Absence of hemarthrosis
(capsular disruption)
- Obese pt low energy fall



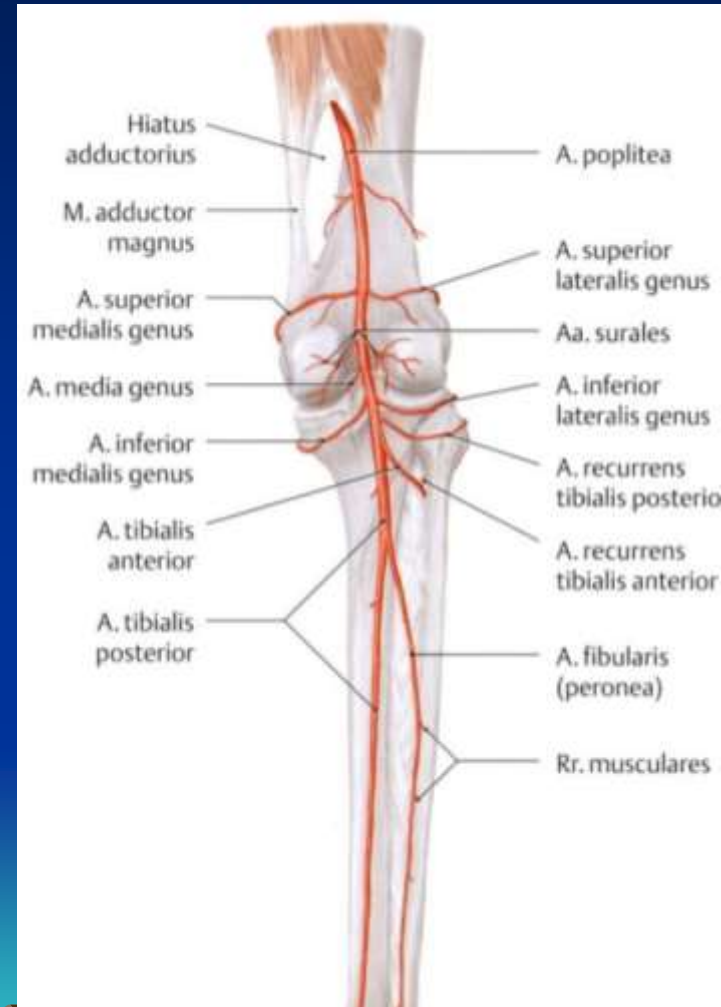
Vascular Examination

- Color, temperature, Pulses
- Dorsalis Pedis a. & Tibialis Posterior a.
- ABI (Ankle Brachial Index)
 - ≥ 0.9 : Serial examination
 - < 0.9 : further study/exploration
 - Johanson, K, JT
- Reduce if dislocated and Re-examine



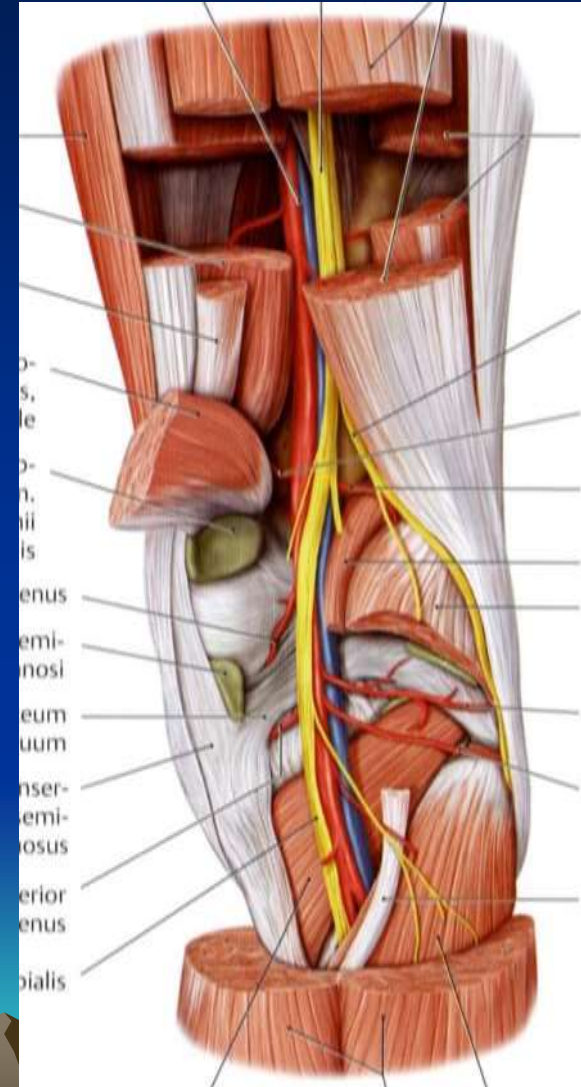
Vascular Injury

- ~20% (5-30%) of all dislocations
- URGENT if ABI <0.9: further study/exploration
- EMERGENCY if NO distal perfusion
- Patterns of Vascular injury
 - rupture
 - incomplete tear
 - intimal injury (may cause thrombosis)



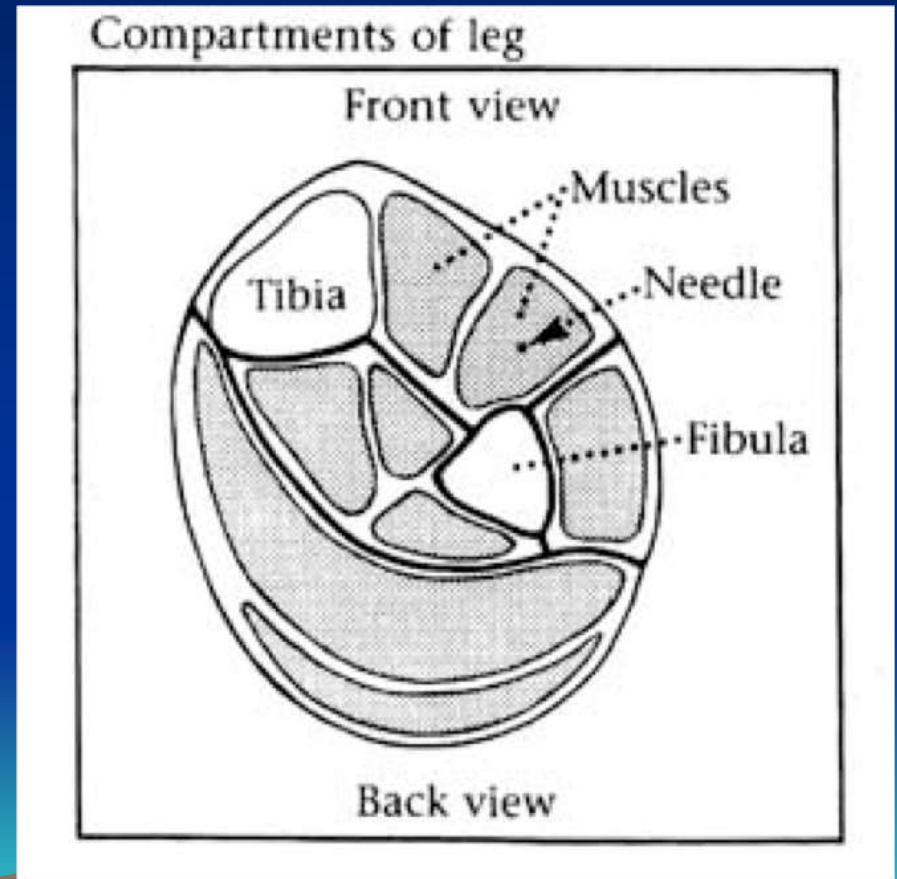
Neurologic Injury

- Common peroneal nerve palsy
- Incidence ~20% (10-40%)
- Most Common with varus injury
- Usually axonothmesis
- **PROGNOSIS is POOR**
- Complete recovery ~ 20%



Compartment Syndrome

- Incidence:
 - 5-15%
- History
 - High-Energy
 - Crush
 - Prolonged Down Time
 - Direct External Compression
- Exam
 - 4 Compartments
 - 6 P's
 - PAIN
 - PAIN WITH PASSIVE STRETCH
 - Paresthesias
 - Pulsless
 - Pallor
 - Paralysis



Compartment Syndrome Remains a Clinical Diagnosis



Priorities



- ABC'S
- Assoc Injuries
- Tetanus
- Antibiotics
- Soft Tissue Management
- Initial Care to final Fixation
- Long term issues

Radiographic Evaluation

- AP, Lateral on Large Cassettes
 - Check joint above & below
- Obliques
 - Internal rotation view
 - Shows postero-lateral fragment
- Traction Films
 - Defines fragments
 - Bridging Ex-fix can provide traction
- Plateau CT scan with reconstruction
 - Obtain after ex fix if using/spanning
 - Shaft fractures for Occult Extension
- Arteriography when necessary (or check ABI > 0.9)
- ? MRI – suspected fxs or soft tissue injury



Timing of Surgery

- Stable, resuscitated patient
- Define fracture(s)
- Soft tissue envelope
 - Swelling
 - Ecchymosis
 - “Damage Control Orthopaedics”
- Positioning of patient
 - Other injuries affect positioning



“Damage Control Orthopaedics”

- Temporary Stabilization
 - Soft Tissue Rest
 - Bony/Joint Stabilization
- Bridging External Fixator
 - Across the Knee
 - Pins Out of Zone of ORIF in Tibia
 - Unstable Dislocations and Vascular Repairs
 - Types V & VI Primarily
- Repair/ORIF When Soft Tissues Allow



Surgical Techniques

- Joint Distraction
 - Temporary Bridging ExFix or Femoral Distractor
- Joint Depression
 - Reduce From Below (Lamina Spreader, Curved Tamps)
 - Bone Graft Defects
- Compress with Lag Screws
- Repair Associated Ligament Avulsions
 - Restore ligamentous stability
- Preserve Meniscus
- Restore Alignment of Proximal Tibia
- Percutaneous Reuction



Unicondylar

- Single plate or screws (I)
- Rarely need locking plate
 - Osteoporotic
 - Only available implant
 - Can use non-locking screws
 - Pre-contoured newer gen plates
- Support depression
 - Bone graft
 - Substitutes



Fixation Lateral Plateau Fractures

- Traditional
 - large fragment “L” or “T” buttress plate
 - 6.5mm subchondral lag screws
 - 4.5mm diaphyseal screw
- Current Recommendation
 - small fragment fixation
 - pre-contoured peri-articular plates
 - clustered subchondral k-wires
 - “rafting” subchondral screw fixation



Bicondylar

- Single Locked Plate
- Dual Plates
 - Definitely if non-locking
- Beware the Posteromedial fragment
 - Direct Reduction and Antiglides Plate
 - Indirect Reduction and AP screws
- Tibial Tuberosity Avulsion
 - AP screws
- Support depression
 - “rafting” subchondral screw fixation



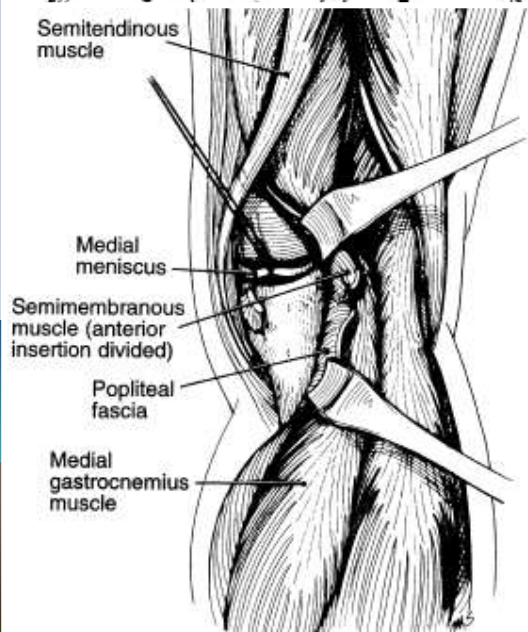
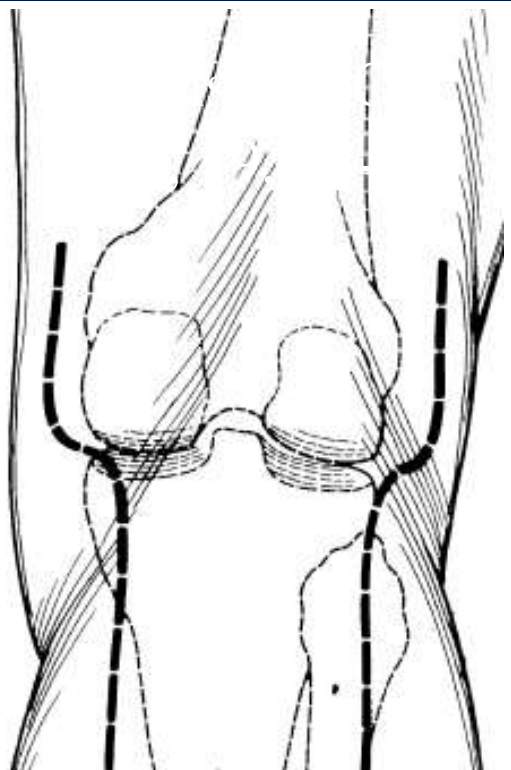
Posteromedial and Posterior Column Fragments

BEWARE !!

- Often missed
- Must Identify
- Must Reduce
 - Increasing Transition to Direct Reduction over Indirect
- Must Stabilize with perpendicular or “Orthogonal” fixation



Posterior Approach(es)



Closed Tibial Shaft Fracture

- Broad Spectrum of Injuries w/ many treatments
- Closed Management
- Intramedullary Nails
- Plates
- External Fixation



Non-Operative Treatment Indications

- Minimal soft tissue damage
- Non-intact fibula
 - Higher rate of nonunion & varus with intact fibula
- Stable fracture pattern
 - $< 5^\circ$ varus/valgus
 - $< 10^\circ$ pro/recurvatum
 - < 1 cm shortening
- Ability to bear weight in cast or fx brace
 - Requires frequent follow-up

Post Tibia Fracture Ankle Motion

- 25% Post Tibia Fracture will lose 25% of Ankle ROM



Surgical Indications

- Patient Characteristics
 - Obesity
 - Poor compliance with non-operative management
 - Need for early mobility
- Injury Characteristics
 - High Energy
 - Moderate soft-tissue injury
 - Open Fracture
 - Compartment Syndrome
 - Ipsilateral Femur Fx
 - Vascular Injury
- Fracture Characteristics
 - Meta-Diaphyseal location
 - Oblique fracture pattern
 - Coronal Angulation $> 5^\circ$
 - Sagittal Angulation $> 10^\circ$
 - Rotation $> 5^\circ$
 - Shortening $> 1\text{cm}$
 - Comminution $> 50\%$ cortical circumference
 - Intact fibula

Surgical Options

- Intramedullary Nail
- ORIF with Plate
- External Fixation
- Combination of fixation



Advantage of IM Nail

- Less malunion
- Early weight-bearing
- Early motion
- Early WB (load sharing)
- Patient satisfaction
 - L Bone, JBJS
- Cost
 - Less expensive to society when compared to casting



Disadvantages of IM Nail

- Anterior knee pain
 - 2/3, improve w/in year
- Risk of infection
- Increased hardware failure with unreamed nails
- Thermal Necrosis
- Medial HW prominence



Reamed vs. Nonreamed Nails

- Reamings (osteogenic)
- Larger Nails (& locking bolts)
 - Hardware failure rare w/ newer nail designs
- Damage to endosteal blood supply?
 - Clinically proven safe even in open fx

Forster Injury '05

Bhandari JOT '00

Reamed vs Unreamed: SPRINT

Trial Bhandari M, Randomized trial of reamed and unreamed intramedullary nailing of tibial shaft fractures *JBJS*, 2008

- Possible benefit of reamed IM nails in closed fractures
- No difference in open fractures
- Delaying reoperation for nonunion for at least 6 months significantly lowers the need for reoperation



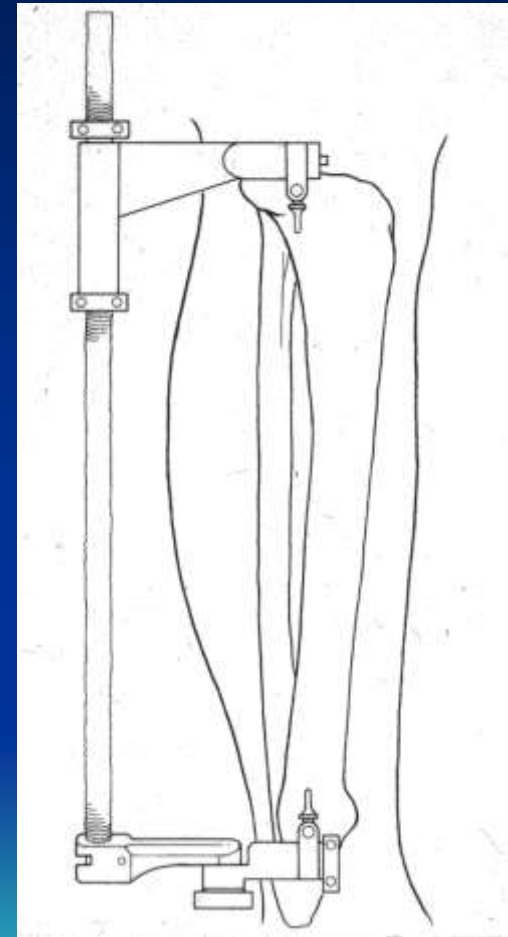
Expanded Indications

- Proximal 1/3 fractures
 - Beware Valgus and Procurvatum
- Distal 1/3 fractures
 - Beware Varus or valgus
 - Beware of intraarticular extension



Hyperflexed position

- Historically Infrapatellar Nailing
- Pulls patella proximally to allow straight starting angle
- Universal distractor



Semiextended Position and now Suprapatellar

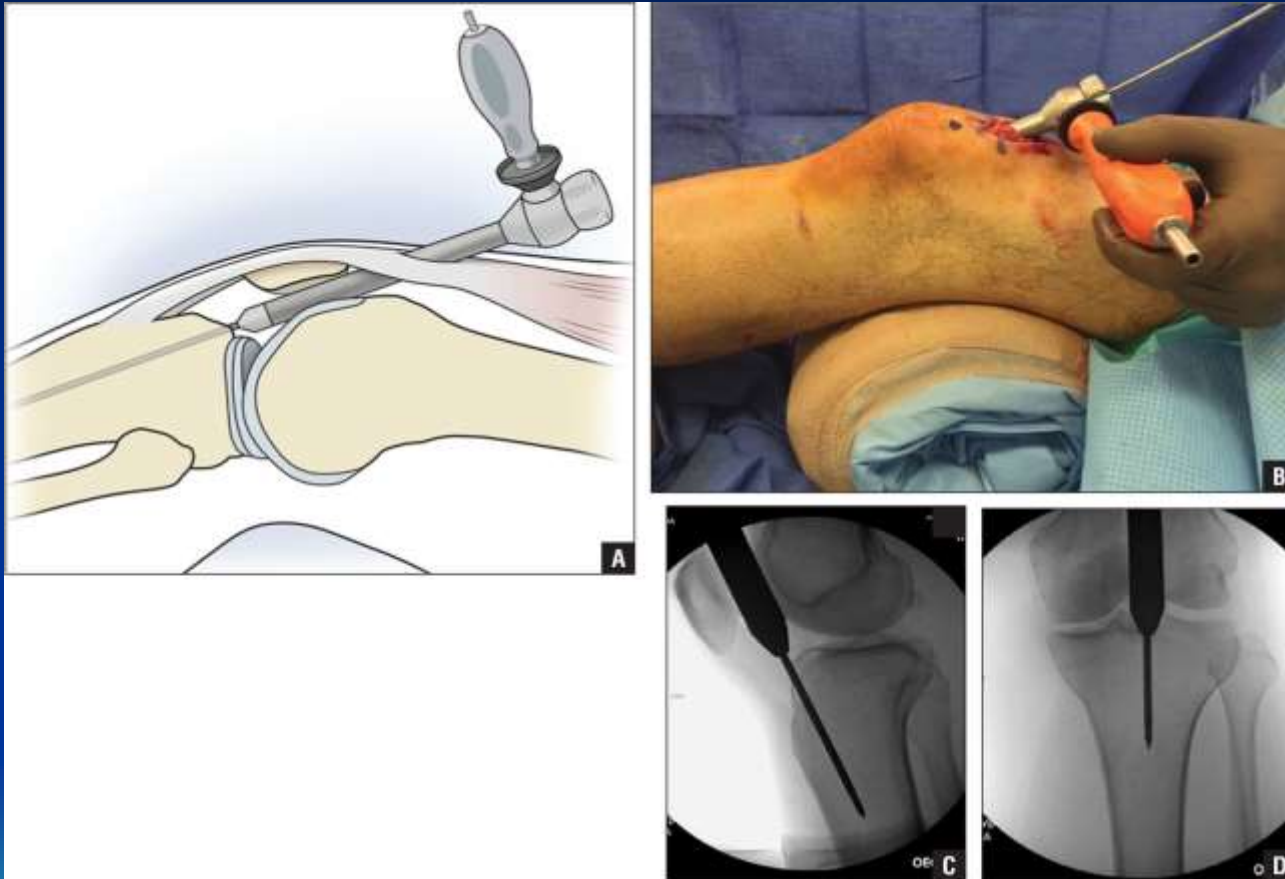
- Neutralize quadriceps pull on proximal fragment
- Medial parapatellar approach
 - subluxate patella laterally
- Use handheld awls to gently ream through the trochlear groove

Tornetta CORR '96

- Now Many Manufacturers offer Suprapatellar Options with Benefits of Semi-extended



Suprapatellar



https://m3.healio.com/~media/journals/ortho/2015/12_december/10_3928_01477447_20151119_06/fig1.jpg

Blocking (Poller) Screws

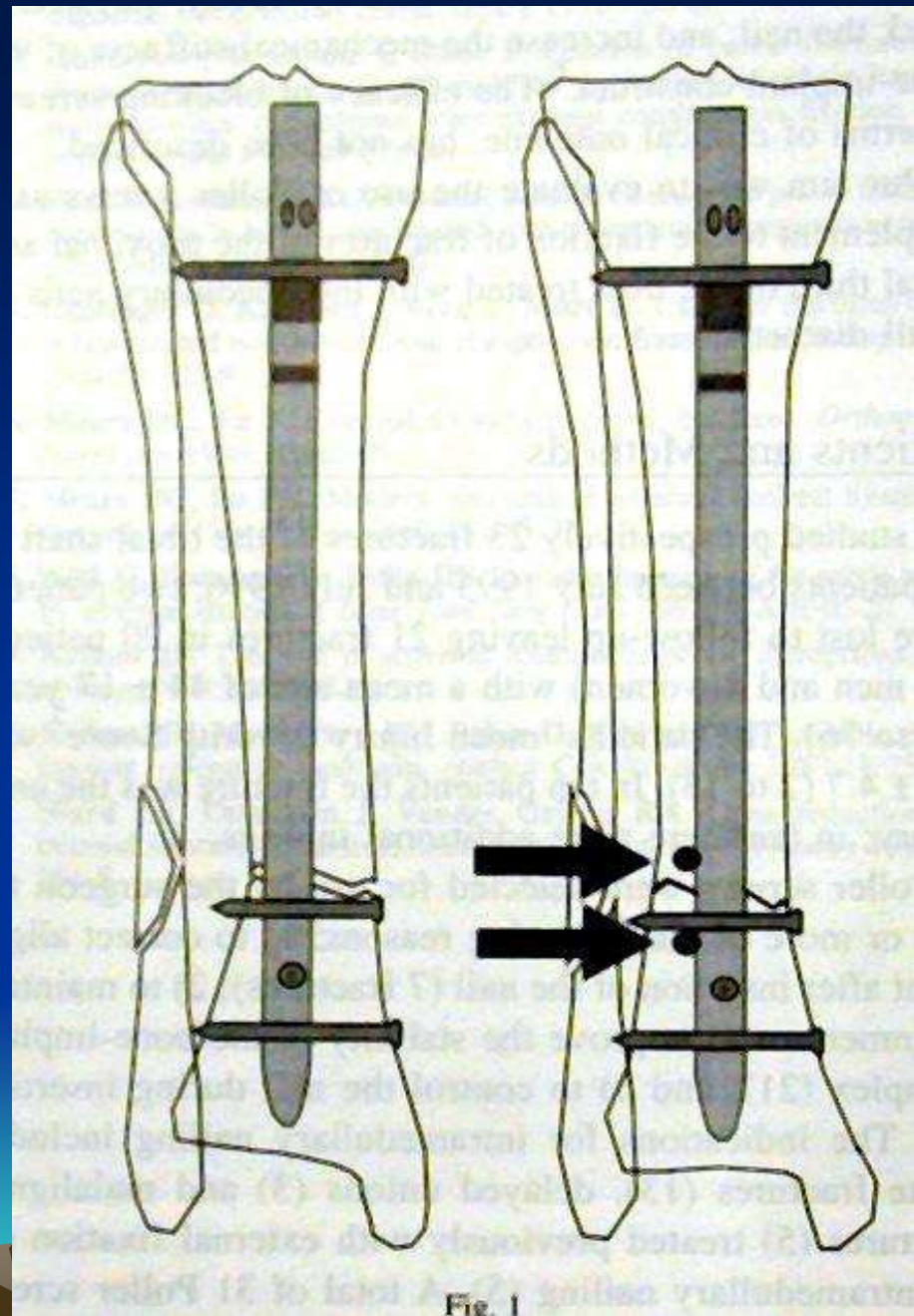
- Functionally narrows IM canal
 - Increases strength and rigidity of fixation
 - Place on concave side of deformity
- 21 patients
 - All healed within 3-12 months
 - Mean alignment 1° valgus, 2° procurvatum

Krettek JBJS '99



Technique

- Screws placed on **concave** side of deformity
- Proximal or distal fractures



Distal Tibial Fractures

- Reduction before reaming
- Distractor
- Fibula plate/nail
- Joy Stick
- Calcaneal Traction

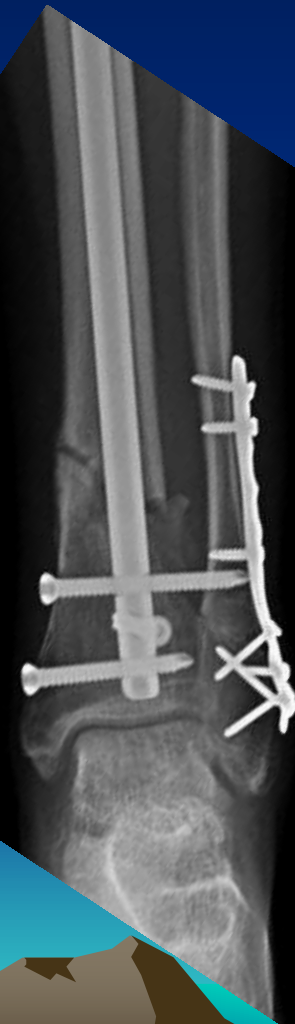


Universal Distractor Reduction

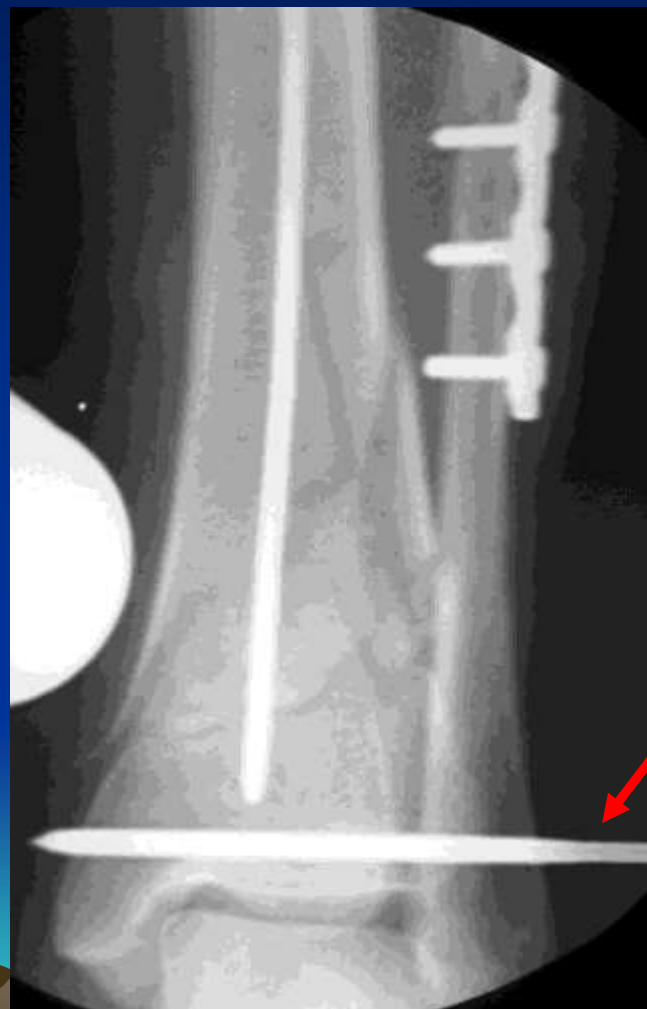


Beuhler JOT '97

Plate Fibula



Distal Tibial Joystick



Outcomes of IM Nailing

- 859 closed tibia fractures
- 92.5% union rate
- 18.5 weeks to union
- 1.9% infection rate
- 4.4% aseptic nonunion

- “Reamed intramedullary nailing will probably continue to be the best method of treating tibial diaphyseal fractures.”

Plating of Tibial Fractures

- 3.5 mm or Narrow 4.5mm DCP plate can be used for shaft fractures
- Newer periarticular plates available for metaphyseal fractures



Subcutaneous Tibial Plating

- Newer alternative is use of limited incisions and subcutaneous plating- requires indirect reduction of fracture and hybrid screw fixation options



Percutaneous Plate Fixation

- Newer percutaneous plating techniques using indirect reduction may be a more beneficial alternative
- Large prospective studies yet to be evaluated



Advantages of Plating

- Anatomic reduction usually obtained
- In low energy fractures
 - 97% G/E results reported
 - Ruedi Injury

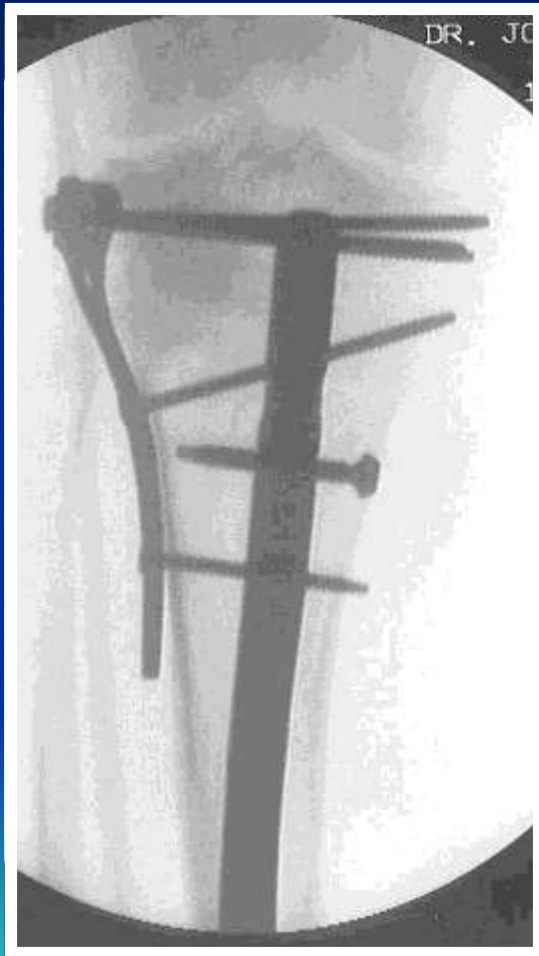


Disadvantages of Plating

- Increased risk of infection and soft tissue problems, especially in high energy fractures
- Higher rate hardware failure than IM nail
- Delayed WB (load bearing)



Combination Reduction



External Fixation

- Generally reserved for DCO Provisional Stability of dislocations and periarticular fxs
- Primary used for DCO Provisional Stability
- Definitive Treatment with Fine Wire/Spatial Frames (Ilizarov)



Advantages of External Fixator

- Can be applied quickly in polytrauma patient
- Allows easy monitoring of soft tissues and compartments
- Modifiable
- No long term deep HW
- Evolution: More Commonly used for Temporary Damage Control



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