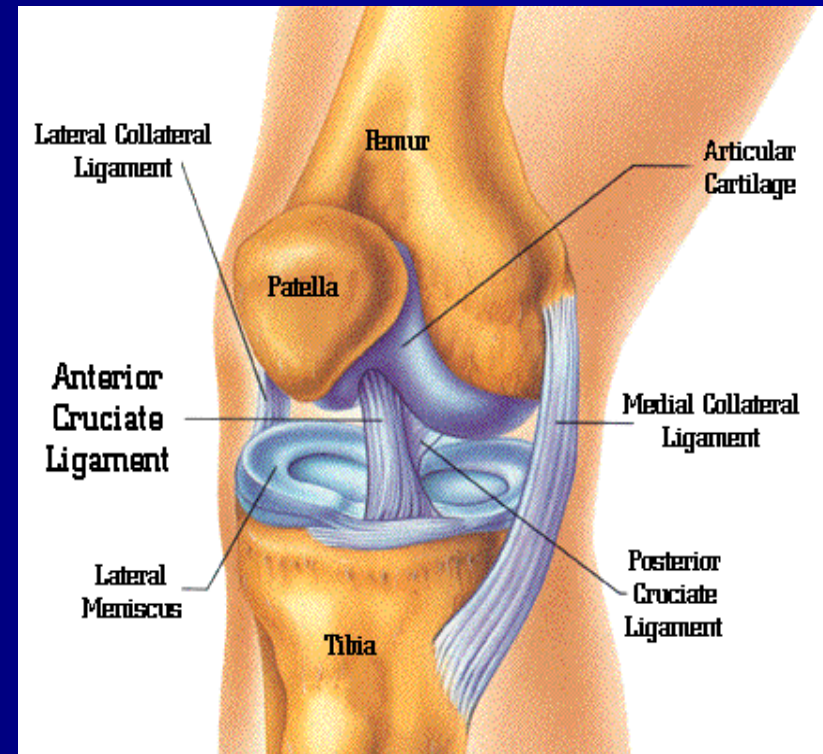


Knee Evaluation

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Quick Facts

- Tibiofemoral Joint (TFJ)
- Normal ROM
 - Flexion 135-140 degrees
 - Extension 0 degrees
- Closed Pack Position
 - Full extension with ER
- Loose Packed Position
 - 25 degrees of flexion



Quick Facts

- Patellofemoral Joint (PFJ)
- Variations in PFJ loading during OKC and CKC activities
- PFJ loading increases:
 - with increased flexion in CKC
 - with increased extension in OKC
- PFJ Loading
- Walking
 - 0.3 x body weight
- Ascending Stairs
 - 2.5 x body weight
- Descending Stairs
 - 3.5 x body weight
- Squatting
 - 7 x body weight



History

- Mechanism of Injury
 - Table 12-1 in Magee
- Past Medical History
- Functional Limitations
- Clicking / Popping
 - At onset / since onset
- Pain
 - Location, description, intensity
- Activities which increase or decrease pain
- Instability during ADL / Functional Activity
- Joint Locking?
- Effusion
 - Now or At Onset
- Gait, Footwear, Training Patterns, ADL
 - Particularly important in overuse conditions

Common Mechanisms of Injury

- Hyperflexion:
 - ACL, PCL
- Hyperextension:
 - ACL, PCL, posterior joint capsule
- Anterior Tibial Translation:
 - ACL, ITB, LCL, MCL, Med & lat jt. Capsule
- Posterior Tibial Translation:
 - PCL, popliteus, medial and lateral joint capsule
- Tibial ER:
 - Post lateral jt. Capsule, MCL, PCL, LCL, ACL
- Tibial IR:
 - Jt. Capsule (ant. Lateral, post medial, post. Lateral), ACL, LCL
- Varus force:
 - LCL, lat. Jt. Capsule, ITB, biceps femoris
- Valgus force:
 - MCL, med. Jt. Capsule, pes anserine muscles, medial meniscus



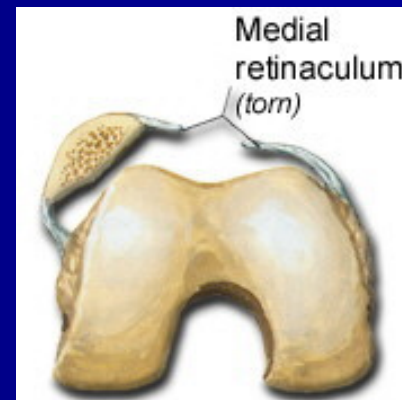
Visual Inspection



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Visual Inspection

- Deformity
 - Osgood-Schlatter Disease
- Swelling
 - Intracapsular swelling
 - Diffuse
 - Knee flexed 15-25 degrees
 - Extracapsular Swelling
 - Localized
 - Baker's Cyst
- Atrophy/Hypertrophy
 - VMO
 - Quadriceps
- Patellar Position
- Genu Valgus
- Genu Varum
- Genu Recurvatum
- Lateral Tibial Torsion
- Medial Tibial Torsion
- "Miserable Malalignment"

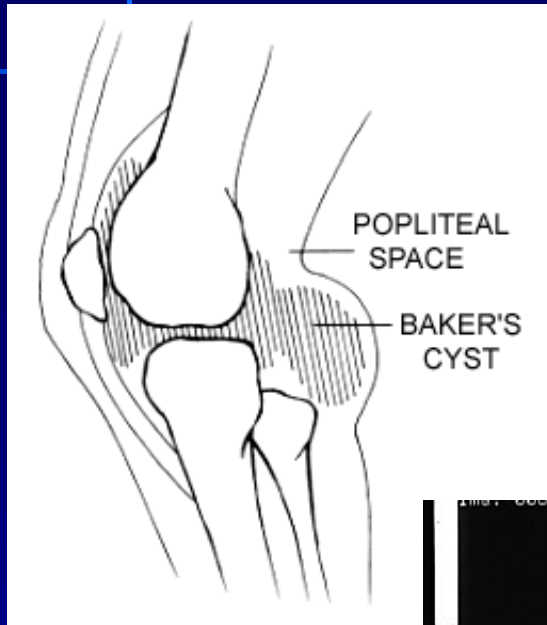


Swelling Assessment



- Brush Test
- Sweep Test
- Ballotable Patella

Baker's Cyst



- Due to chronic trauma to the knee, internal derangement, recurrent effusion
- Typically large, soft, painless mass
- Found between the gastrocnemius and semimembranosus (popliteal fossa)

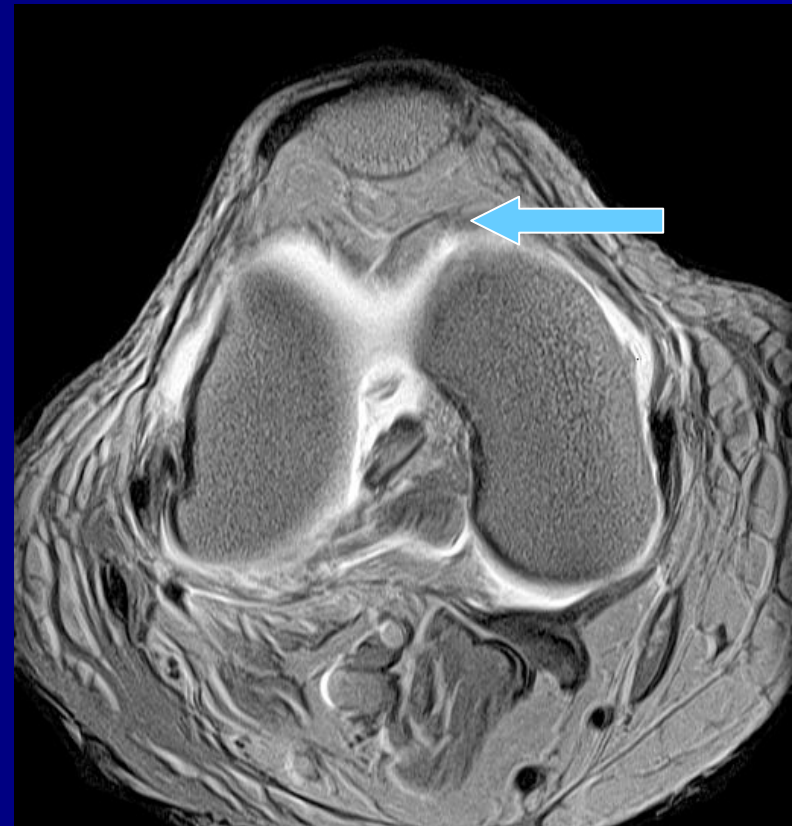
Patellar Position

- Patella Baja
- Patella Alta
 - Camel Sign
 - Second “hump” is infrapatellar fat pad or infrapatellar bursa
- Patellar Tilt
 - “Grasshopper Eyes”
 - Tilt outward
 - “Squinting”
 - Tilt inward
- Lateral Glide
- Lateral Rotation



Infrapatellar fat pad

- From the lower pole of the patella to the tibia posterior to the patellar tendon
- Shock absorber and nutrition source for the tendon



Miserable Malalignment

- Increased Femoral Anteversion
- Excessive Lateral Joint Compression
- Excessive Q-Angle
- Patellar Subluxation
- Lateral Tibial Torsion
- STJ pronation

Figure: Courtesy of Elizabeth Arendt, MD

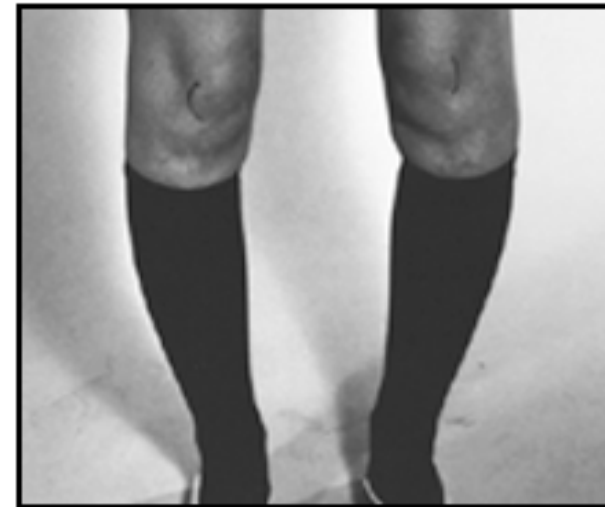


Figure 1. Standing leg alignment of a young woman with severe "miserable malalignment syndrome" demonstrates increased femoral anteversion that produces the following posture characteristics: increased internal rotation of the hip, high Q angle, tibia vara, external tibial torsion, and pronated flat feet.

Palpation

- Pain
- Point Tenderness
- Swelling
- Deformity
- Temperature
- Patellar Position



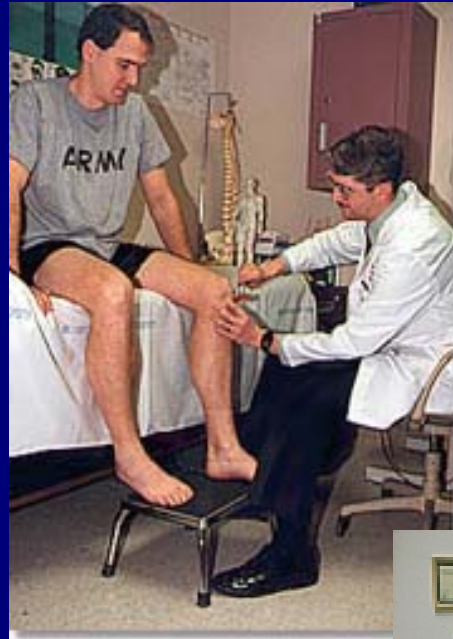
Range of Motion

- Tibiofemoral Joint
 - Flexion
 - Extension
 - Internal Rotation
 - External Rotation
- Patellofemoral Joint
 - Assess motion & tracking of patella
- Hip & Ankle (as needed)

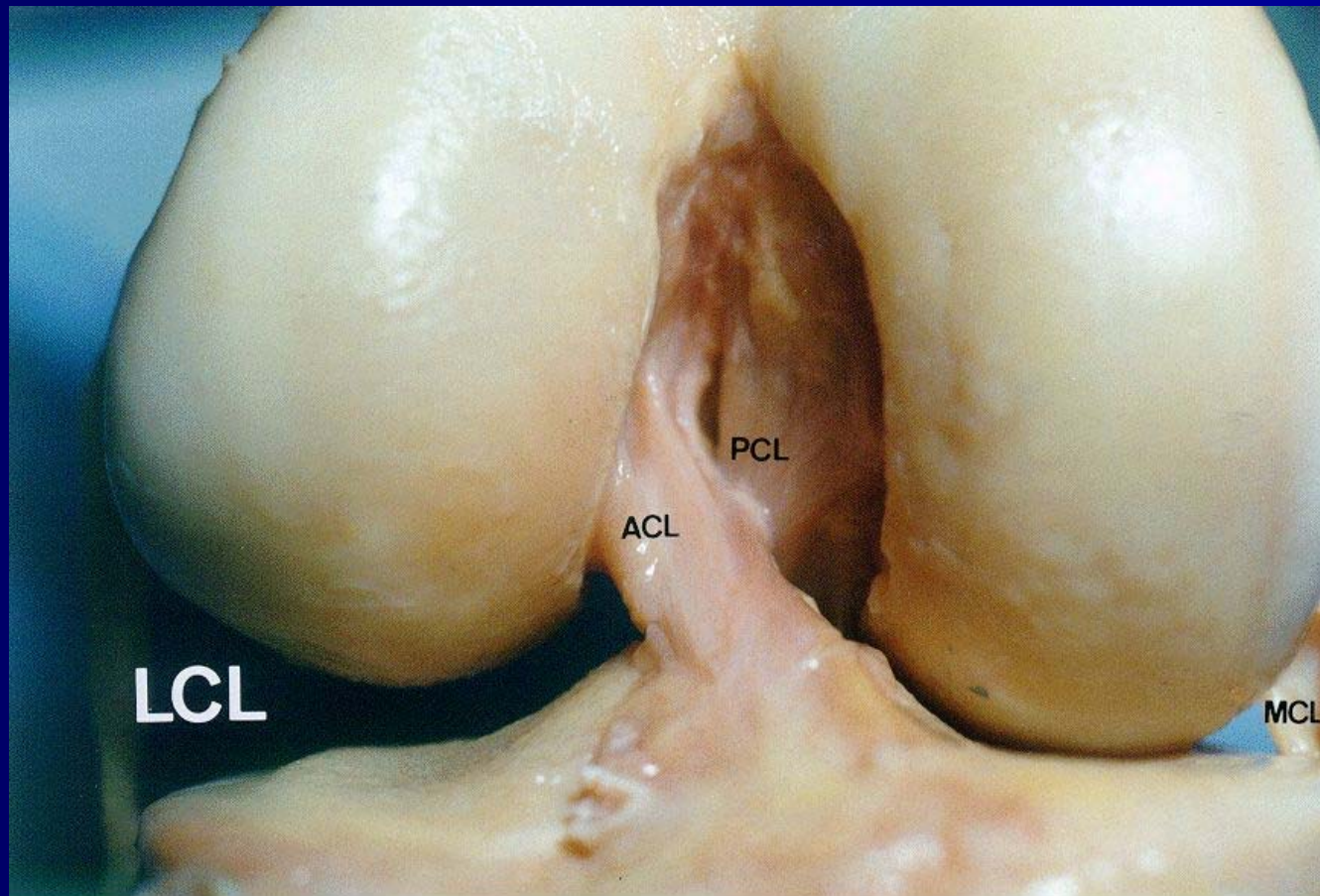


Manual Muscle Testing

- Quadriceps
- Hamstrings
- Sartorius
- Gracilis
- Gastrocnemius
- Hip Musculature
 - As needed



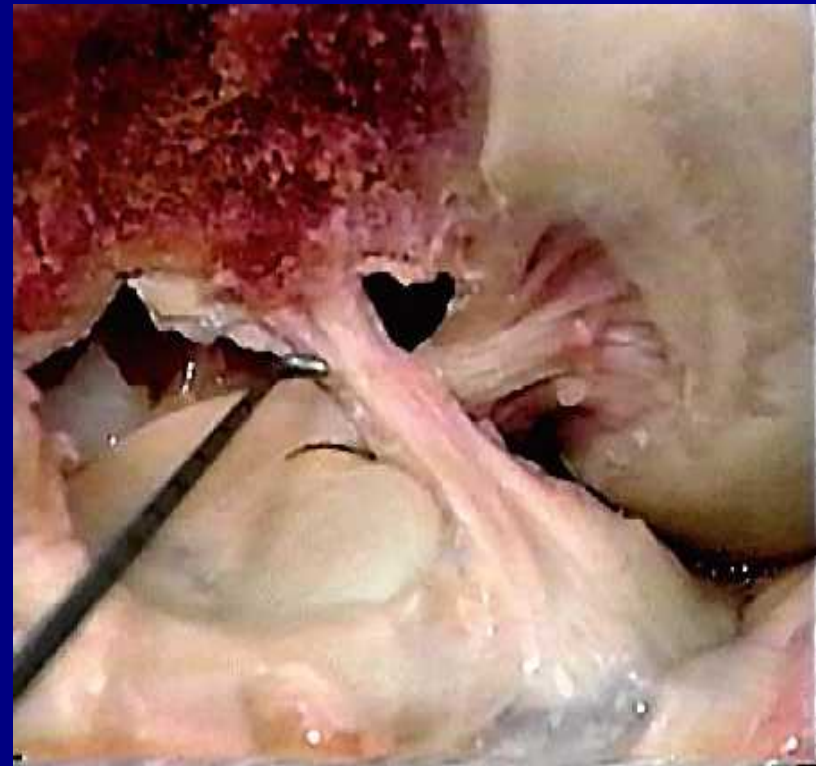
Special Tests



Interactive Knee 1.1 © 2000 Primal Pictures Ltd.

Anatomy of the ACL

- 3 strands
- Anterior medial tibia to posterior lateral femur
- Prevent anterior tibial displacement on femur
- Secondly, prevents hyperextension, varus & valgus stresses



Biomechanics of the ACL



- Most injuries occur in Closed Kinetic Chain
- Least stress on ACL between 30-60 degrees of flexion
- Anteromedial bundle tight in flexion & extension
- Posterior lateral bundle tight only in extension

Lachman's Test

- Best acute ACL test
- Best on field test
- (+) test is a "mushy" or "empty" end-feel
- False (-) if tibia is IR or femur is not properly stabilized



Anterior Drawer Test

- (+) Test is increased anterior tibial translation over 6 mm
- (+) test indicates:
 - ACL (anteromedial bundle)
 - posterior lateral capsule
 - posterior medial capsule
 - MCL (deep fibers)
 - ITB
 - Arcuate complex
- False (-) if only ACL is torn
- False (-) if there is swelling or hamstring spasm
- False (+) if there is a posterior sag sign present



Slocum's Test



- Tests for multi-planar instability
- ALRI- Anterior lateral rotary instability
 - (+) test indicates:
 - ACL, posterior lateral capsule, arcuate complex, LCL & PCL
- AMRI- Anterior medial rotary instability
 - (+) test indicates:
 - MCL (superficial), posterior oblique, posterior medial capsule, ACL

Lateral Pivot Shift Maneuver



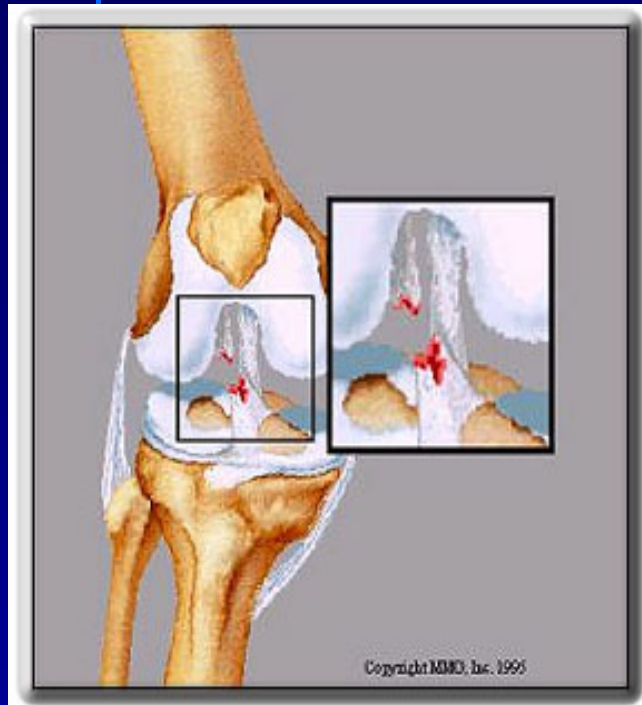
- Tests for ACL and posterolateral rotary instability
 - Posterolateral capsule
 - Arcuate complex
- (+) test is the tibia reduces on the femur at 30 to 40 degrees of flexion, subluxation of the tibia on extension

KT 1000 Testing

- Clinical Uses
- Bilateral Comparison
(>5 degrees)
- Adjunct to Overall Assessment
- Patient Position
- Effect of Effusion
- Validity
 - Tyler et al 1999
- Reliability

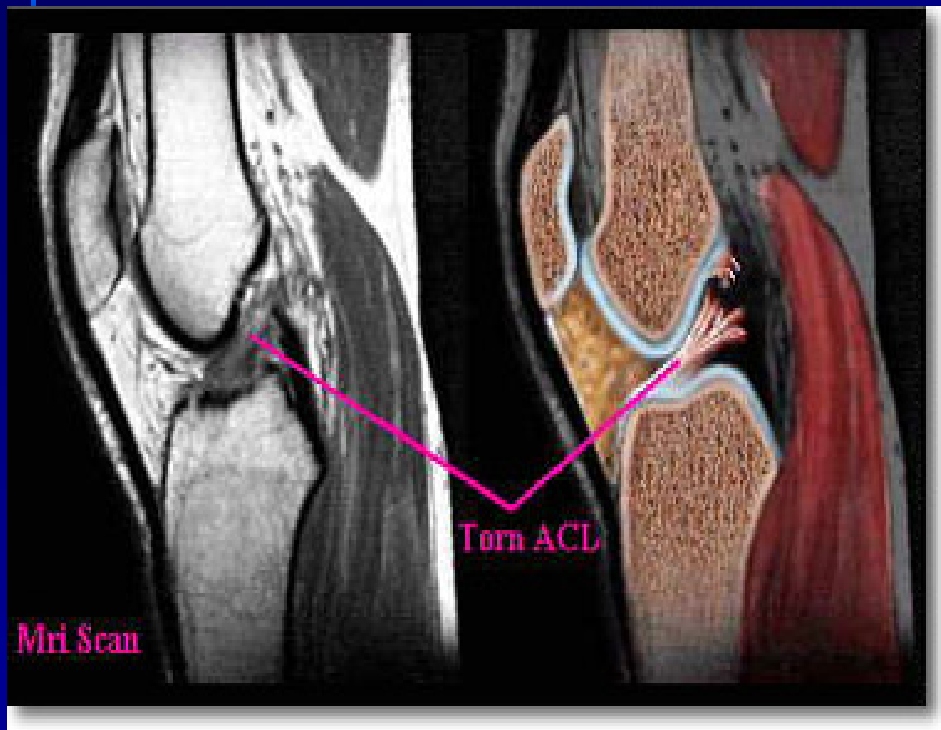


ACL Tears



- Most common mechanisms
 - Contact:
 - CKC with foot ER w/ valgus stress
 - Hyperextension
 - direct hit on the posterior tibia
 - Non-Contact:
 - Most common
 - Due to sudden deceleration
 - Sudden landing, cutting, or pivoting
- Patient will c/o “buckling” or “giving away”, typically will hear and/or feel a “pop”

ACL Tears



- Predisposing factors:
 - Muscular weakness
 - Shoes/athletic surface
 - Hyperpronator
 - Anteverted hips
 - Menstrual cycle
 - Joint laxity
 - Small intercondylar notch
 - Genu recurvatum
 - Small ACL

ACL Injury in Women

- Increased Joint Laxity
- LE Anatomical Alignment
- Intercondylar Notch Size
- Hormonal Variations
- ACL Size
- Skill & Experience
- Neuromuscular Control
- LE Strength & Endurance

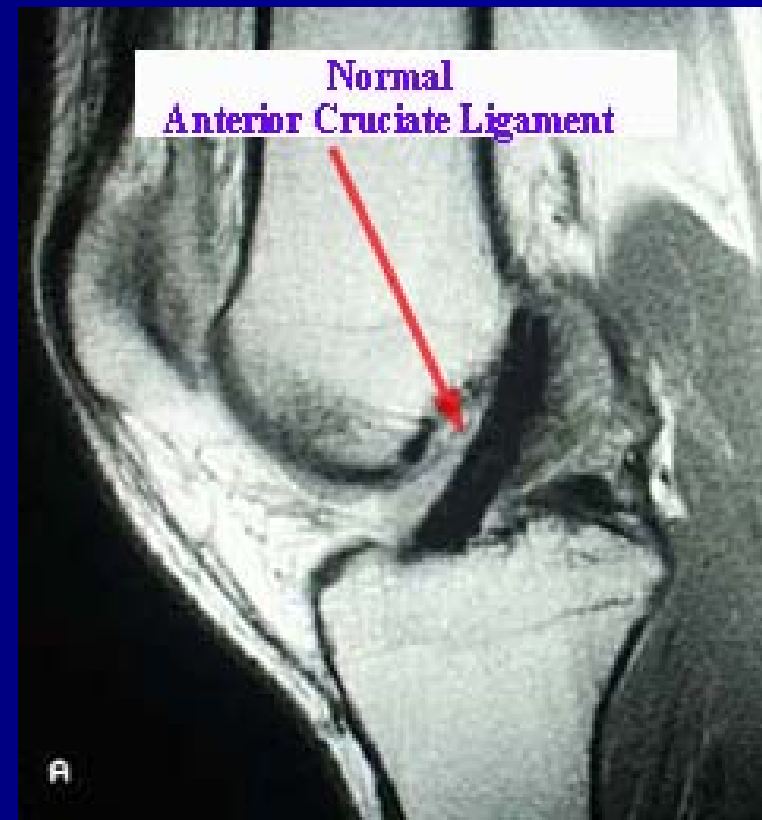
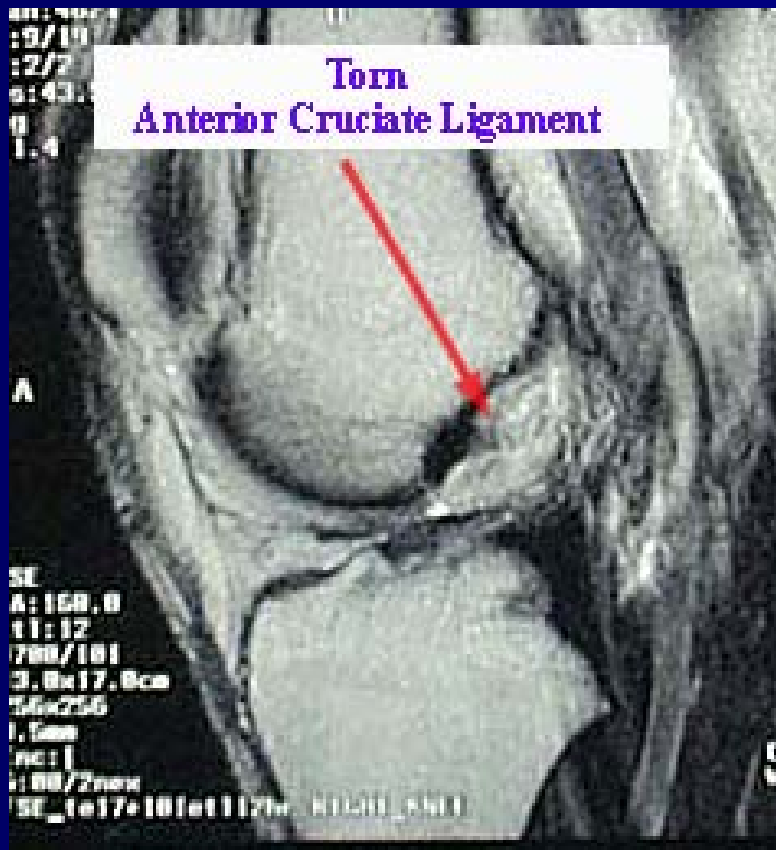


Diagnostic Imaging



Why perform a radiographic knee series after ACL Injury?

Diagnostic Imaging



Why perform an MRI after ACL injury?

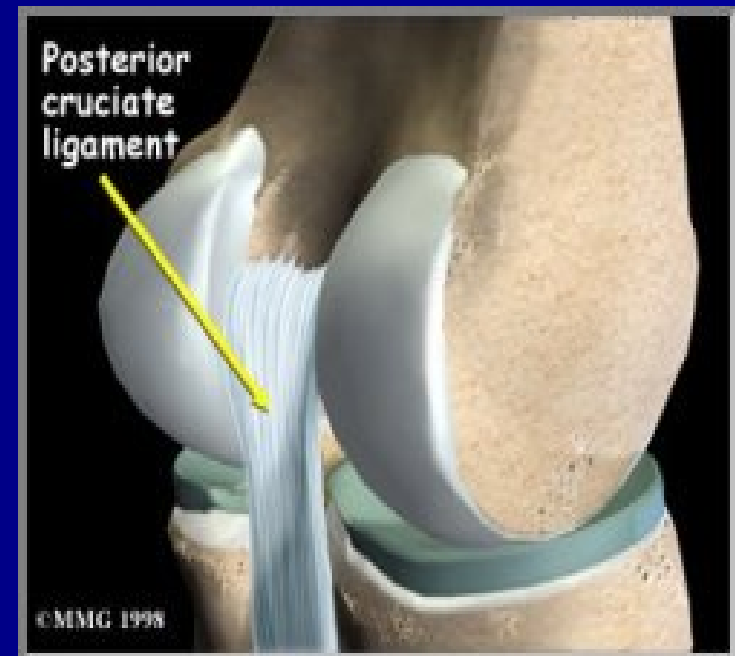
PCL Biomechanics



- Functions:
 - Primary stabilizer of the knee against posterior movement of the tibia on the femur
 - Prevents flexion, extension, and hyperextension
- Taut at 30 degrees of flexion
 - posterior lateral fibers loose in early flexion

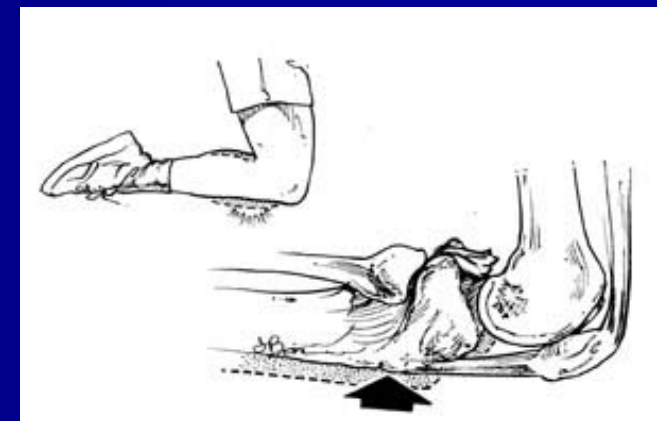
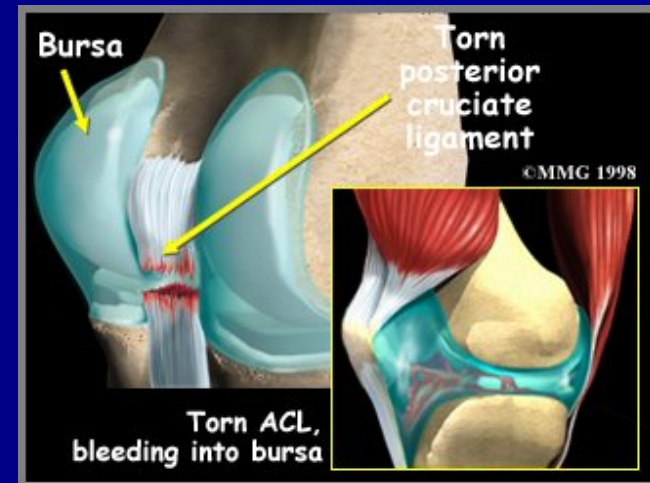
Posterior Cruciate Ligament

- Two bundles
 - Anterolateral, taut in flexion
 - Posteromedial, taut in extension
- Orientation prevents posterior motion of tibia
- PCL larger & stronger than ACL
 - CSA 120-150% larger
 - CSA AL 2x PM
- Consider associated role of posterolateral complex when discussing PCL
 - LCL
 - Popliteus Complex
 - Arcuate Ligament
 - Posterior Lateral Capsule



PCL Injuries

- Very rare in athletics, usually due to MVA
 - Due to hyperextension, hyperflexion, or the tibia being forced posteriorly on the femur
 - Only 33% related to sports
- Isolated PCL Injuries unusual
 - Assess other ligaments
- Avulsion Injuries
- Mid-Substance Tears



Posterior Drawer Test

- Tests for posterior instability
- Make sure that there is no anterior translation prior to performing test
- (+) Test indicates:
 - PCL
 - Arcuate Complex
 - Possibly ACL ???



Rubenstein, et al 1994 found posterior drawer test 90% sensitive for PCL injury (versus 58% for Quadriceps Active Test & 26% for Reverse Pivot Shift Test). Clinical exam on whole was 96% effective in detecting PCL dysfunction

Posterior Drawer Test

Figure: Mary Albury-Noyes

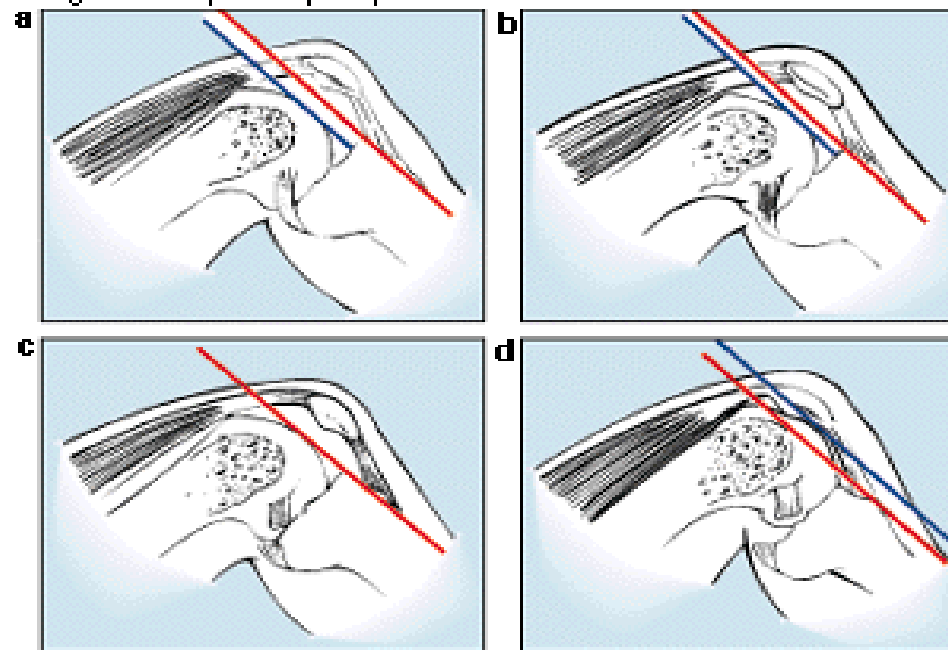
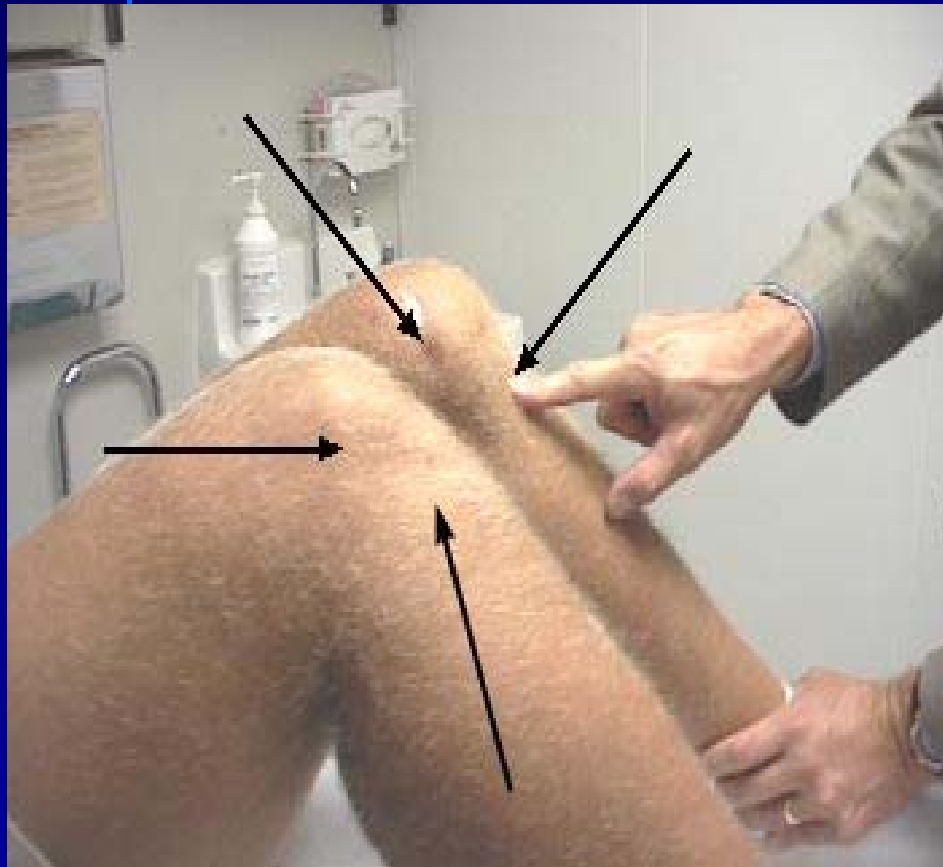


Figure 2. When performing a posterior drawer test on a patient who has a suspected PCL injury, the test is negative (a) if when the examiner pushes the tibia it lies 1 cm anterior to the femoral condyle when the knee is flexed 90°. A grade 1 injury (b) is present if the tibia translates posteriorly, but remains anterior to the femoral condyle; a grade 2 injury (c) is present if the tibia translates posteriorly to lie flush with the femoral condyle; and a grade 3 injury (d) is present if the tibia translates to a position posterior to the femoral condyle.

Positive Posterior Drawer

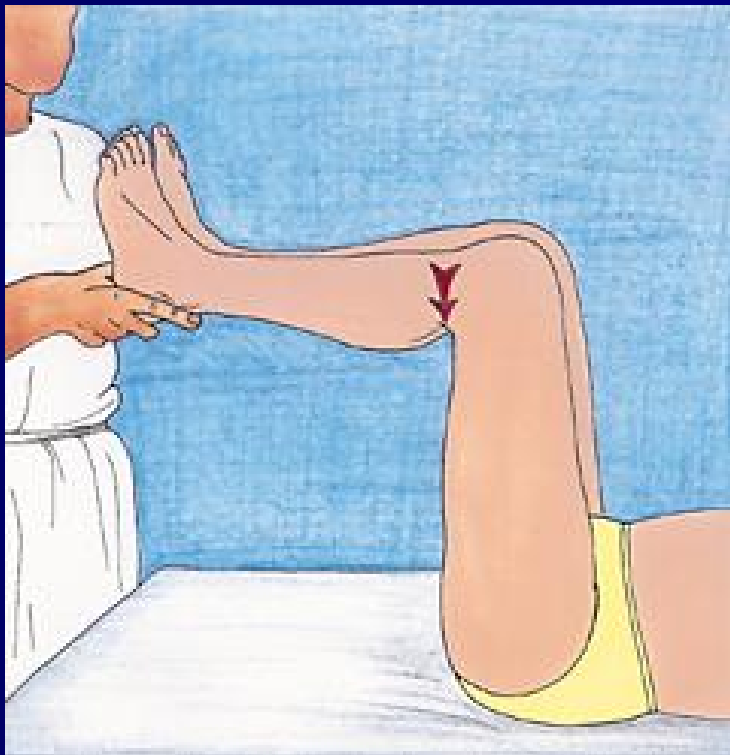


Posterior Sag Test



- Tests for posterior tibial translation
- Tibia "drops back" or sags back on the femur
- Medial tibial plateau typically extends 1 cm anteriorly
- (+) test is when "step" is lost
- (+) Test indicates:
 - PCL
 - Arcuate complex
 - ACL????

Godfrey's Test



- Tests for posterior cruciate ligament damage
- (+) test is a posterior displacement of the tibial tuberosity

Grading PCL Injuries

- Studies from
 - Gollehon, et al., 1987
 - Noyes, et al., 1988
- Do isolated PCL injuries need to be repaired?
- Combined Injuries?
- Evaluation findings?
- Loss of function & instability most prevalent in what position?

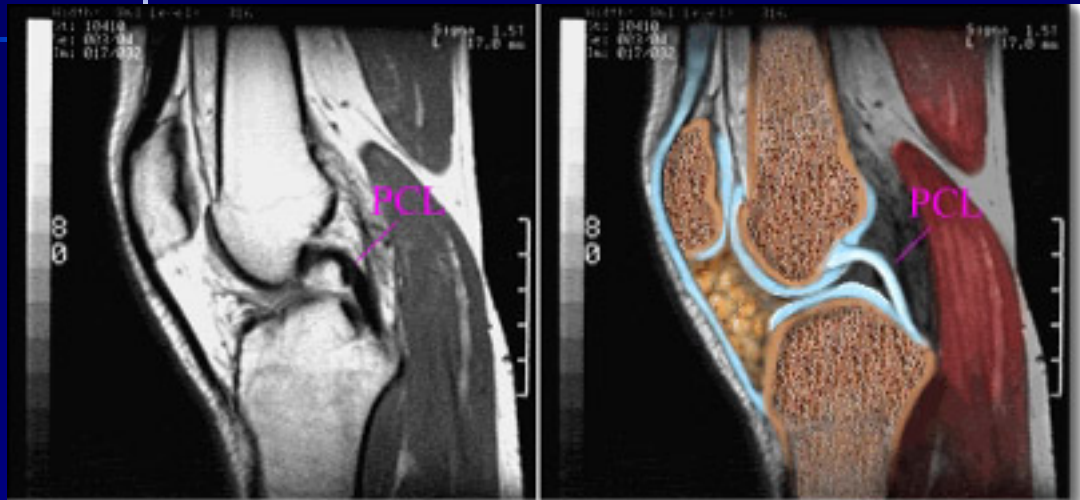


Diagnostic Testing

- Radiographs
- MRI
 - 96-100% accurate in detecting PCL injury

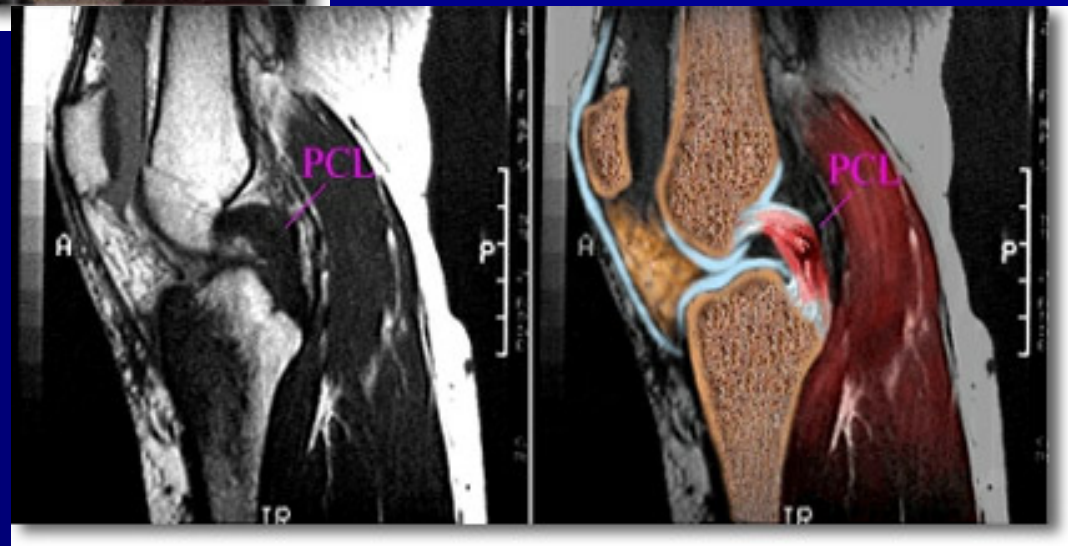


Diagnostic Testing

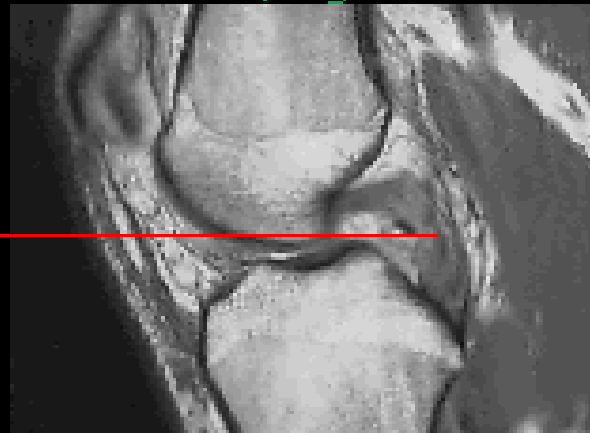


Normal MRI

Torn PCL

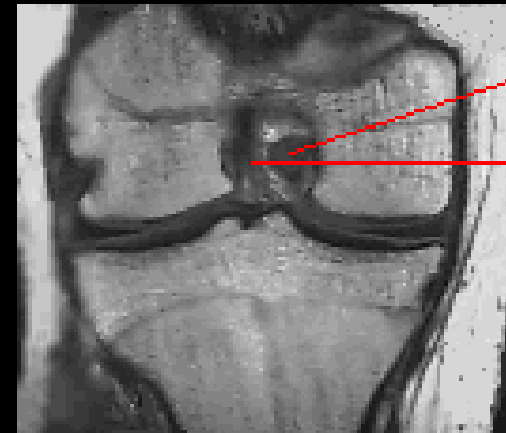


PD W.I., sagittal C-S



(1)

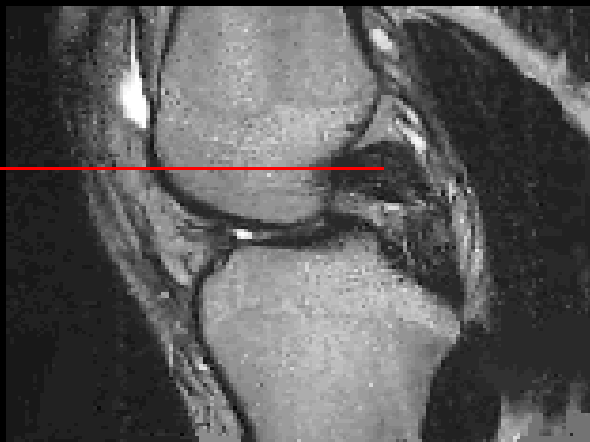
T1 W.I., coronal C-S



(1)

(2)

T2 W.I., sagittal C-S



(1)

T1 W.I., coronal C-S

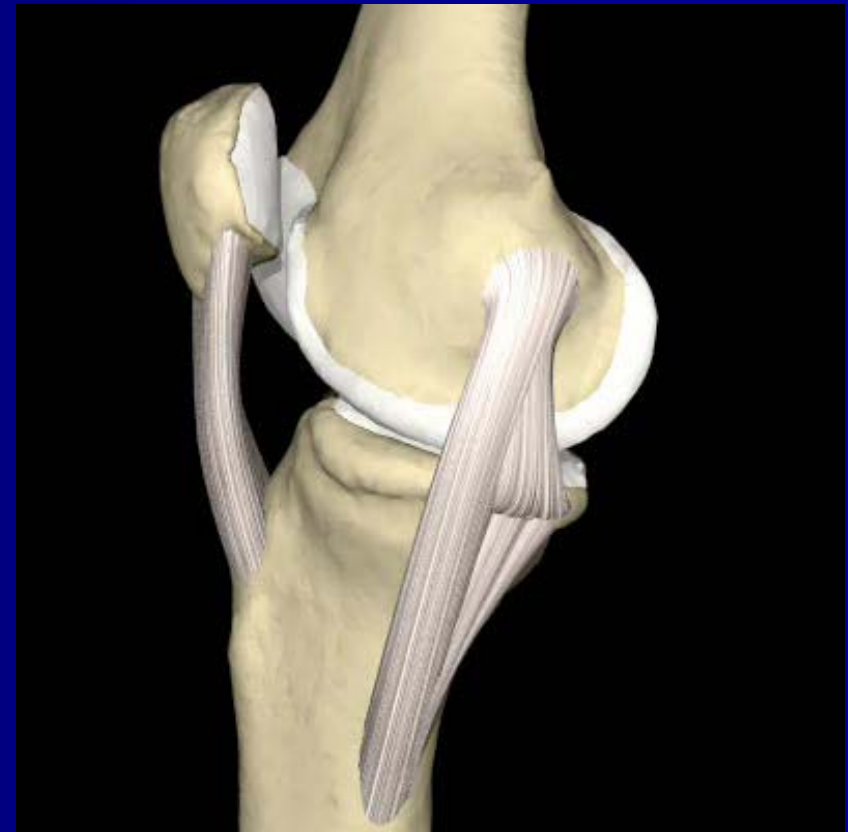


(1)

- (1) Irregular and thickened posterior cruciate ligament
(2) Anterior cruciate ligament

MCL Biomechanics

- Primary role is to prevent against a valgus force and external rotation of the tibia
- Throughout Full Range of Motion:
 - Both fibers are taut in full extension
 - Anterior fibers are taut in flexion
 - Posterior fibers are taut in mid range



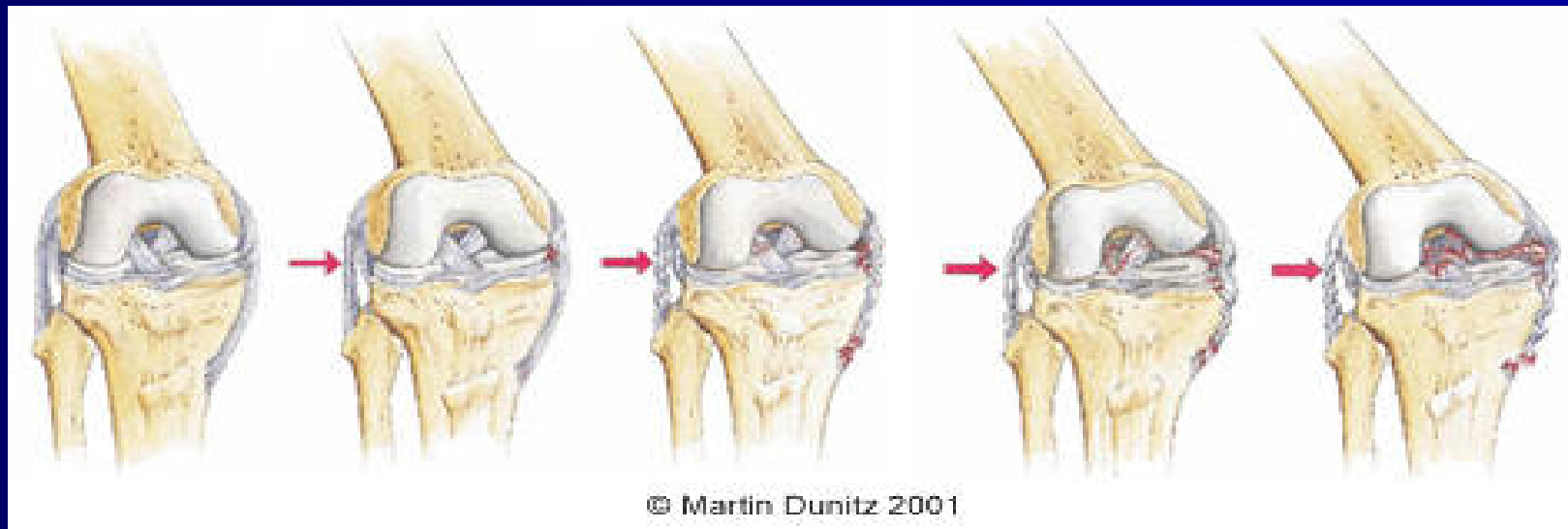
Valgus Stress Test

- Assesses medial instability
- Must be tested in 0° and 30°
- (+) Test in 0°
 - MCL (superficial and deep)
 - Posterior oblique ligament
 - Posterior medial capsule
 - ACL/PCL
- (+) Test in 30°
 - MCL (superficial)
 - Posterior oblique ligament
 - PCL
 - Posterior medial capsule
- Grading Sprains



McClure et al 1989 found poor intertester reliability on valgus stress test at 0 and 30 degrees using 3 PT to evaluate 50 patients

MCL Sprains



- Typically due to valgus forces in CKC
 - Foot typically in neutral or externally rotated
- Most frequently injured ligament in the knee
- Usually no joint effusion unless deep portion affected since primarily located outside the joint capsule

LCL Biomechanics



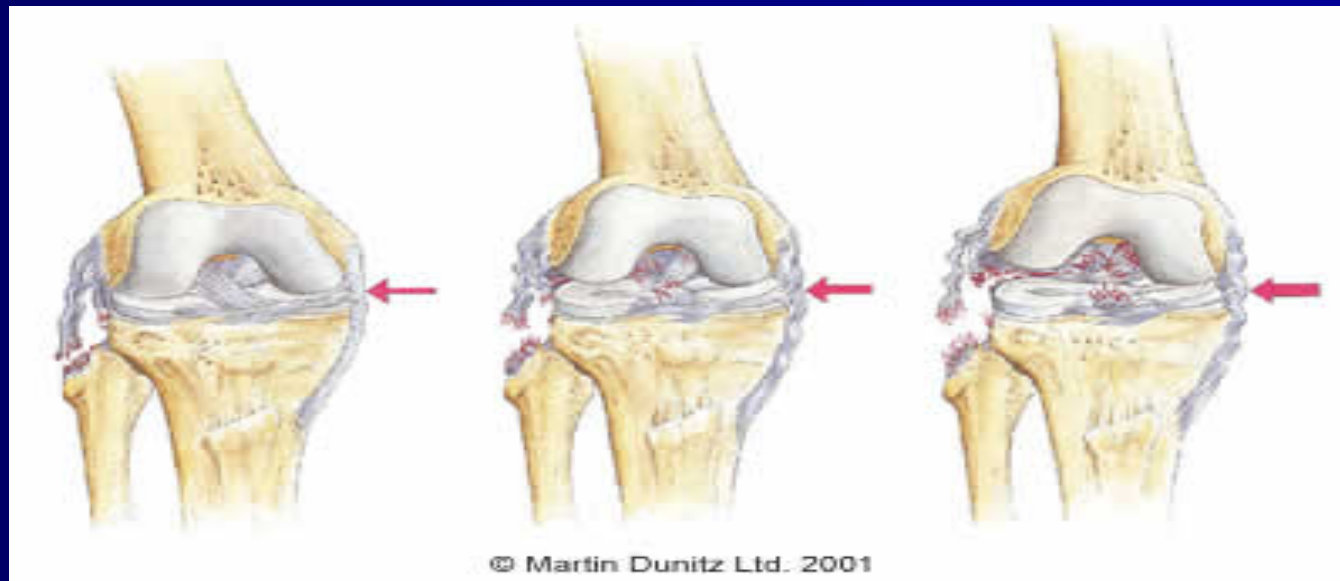
- Primary role is to protect from varus forces and external rotation of the tibia, assists in 2° restraint for anterior and posterior tibial translation
- Throughout Range of motion:
 - Is taut during extension
 - Loose during flexion
 - Especially after 30° of flexion

Varus Stress Test

- Assesses lateral instability
- Must be tested in 0° and 20/30° flexion
- (+) Test in 0°
 - LCL
 - Posterior Lateral Capsule
 - Arcuate Complex
 - PCL/ACL
- (+) Test in 30°
 - LCL
 - Posterior lateral capsule
 - Arcuate complex
- Grading Sprains



LCL Sprains

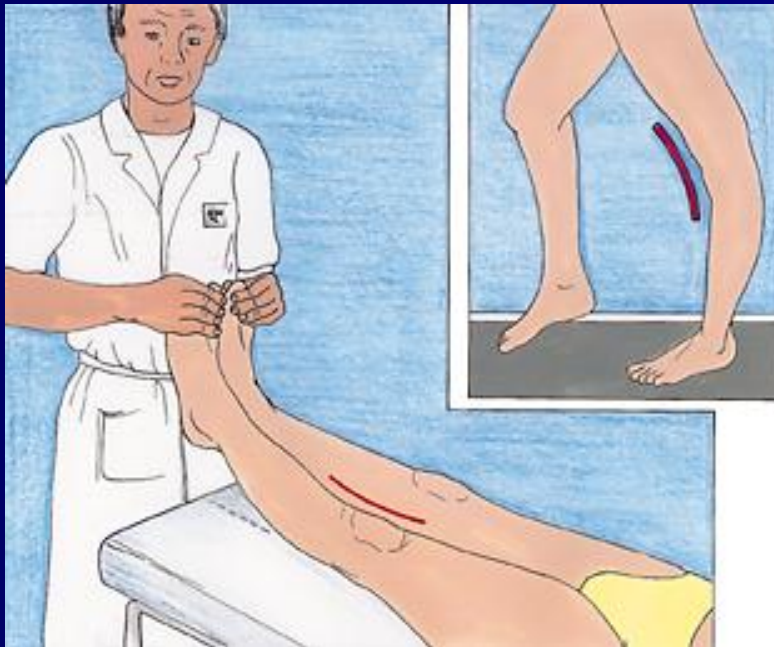


- Typically due to varus forces, especially in CKC position with leg adducted and tibia internally rotated
- Usually occur during contact sports
- Typically has limited joint effusion since it is located outside of the joint capsule

Rotatory Instabilities

- With LCL Injury
 - Consider status of ACL / PCL / Mensicus
 - Consider Rotatory Instabilities as well
- Tibial Rotation Cruciates VS Collaterals
 - When the Tibia Externally Rotates
 - the collaterals become taut
 - cruciates relax
 - When the Tibia Internally Rotates
 - the collaterals become lax
 - cruciates become taut

External Rotation Recurvatum Test



- Tests for posterolateral rotary instability
- (+) test is increased hyperextension and external tibial rotation
- (+) test indicates:
 - PCL
 - LCL
 - Posterolateral capsule
 - Arcuate complex

Dial Test

- Tests for posterolateral rotary instability
- Loomer , 1991 found Dial Test more effective than Hughston Test for detecting posterolateral injury
- Stabilize femur & ER foot with knee flexed to 30 degrees & 90 degrees
- (+) test is increased external tibial rotation greater than 10 degrees
- (+) test indicates:
 - PCL
 - LCL
 - Posterolateral capsule

Hughston Posteromedial Drawer Test

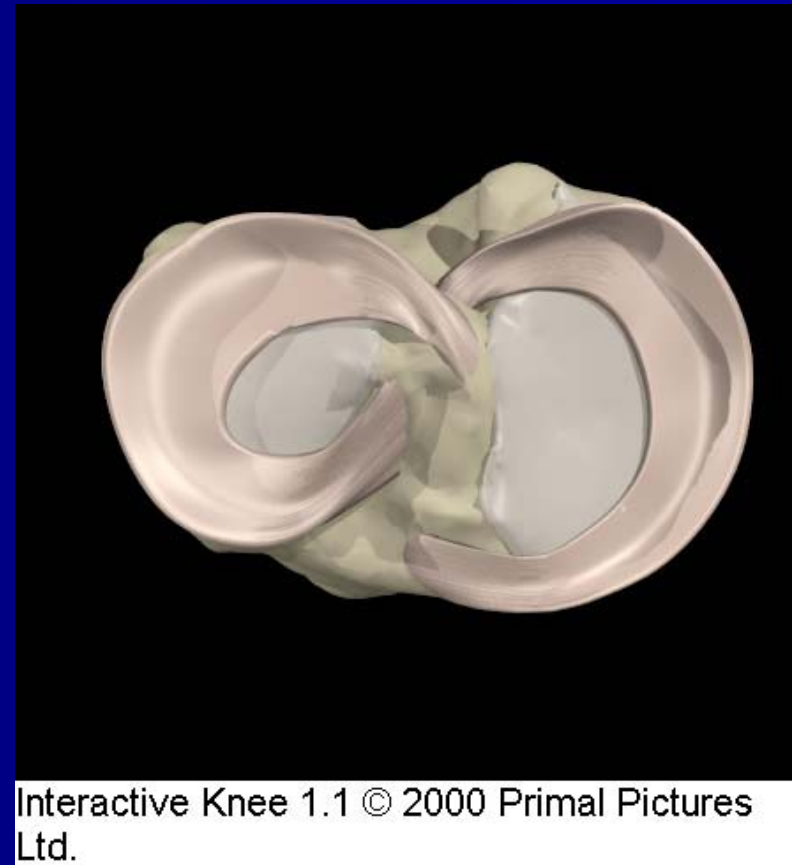
- Tests for posteromedial rotatory instability
- (+) test is posterior tibial displacement, especially off the medial tibial condyle
- (+) test indicates:
 - PCL
 - Posteromedial capsule
 - MCL
 - Posterior oblique ligament

Hughston Posterolateral Drawer Test

- Tests for posterolateral rotatory instability
- (+) test is posterior tibial displacement, especially off the lateral tibial condyle
- (+) test indicates:
 - PCL
 - Posterolateral capsule
 - LCL
 - Arcuate complex

Meniscal Functions

- Deepens the articulation and fills the gaps that normally occur during the knee's articulation
- Primary Functions
 - Load distribution
 - Joint Stability
 - Shock Absorption
- Secondary Functions
 - Joint Lubrication
 - Articular Cartilage Nutrition
 - Proprioceptive Feedback



Mechanism of Injury

- Trauma
 - Compression
 - Rotational Force
 - Valgus Force
 - Usually Combination of Forces
- Degenerative Changes
 - Greater than 30 years old
 - No PMHX required
 - Often due to MOI that “seemed harmless” at time

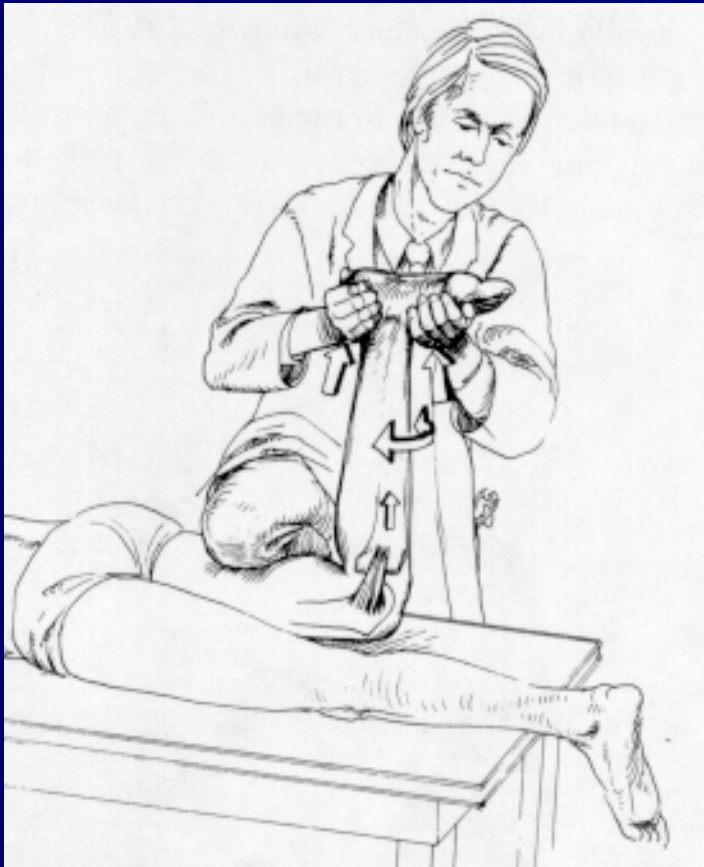


Noyes, 2002 states 60% of meniscal injuries associated with ACL injury

Clinical Presentation

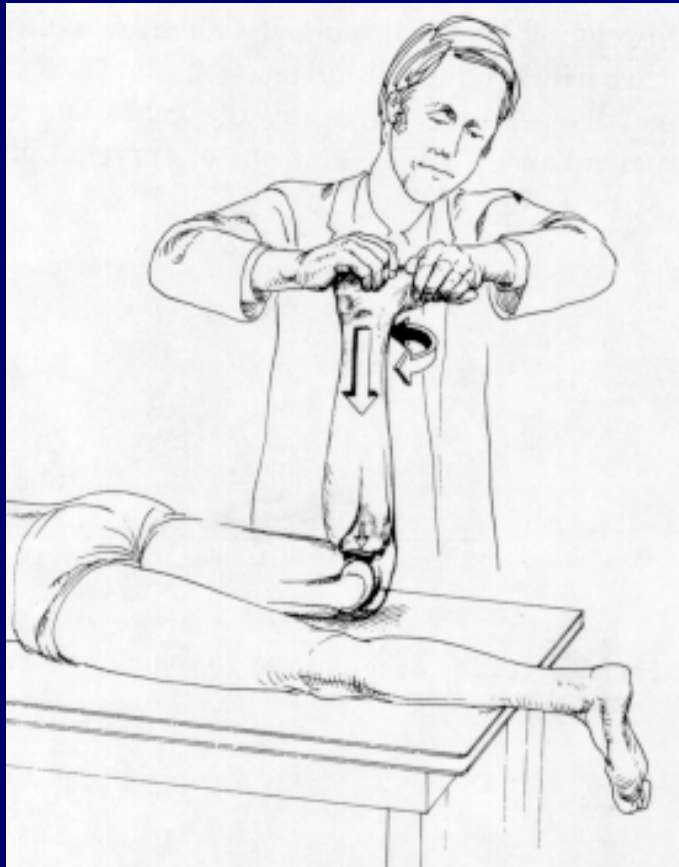
- History
- Pain
- Catching
- Buckling / Giving Way
- Joint Stiffness
- Antalgic Gait
- Joint Line Pain
 - Shelbourne et al 1995
 - Medial joint line pain is 34.5% predictor of meniscal injury
 - Lateral joint line pain is 49.1 % predictor of meniscal injury
- Effusion
- Clicking during ROM
- Increased Pain in full flexion
- Pain with Squatting
 - “Duck Walk”
- Pain with Valgus / Varus Stress Testing
- Rule Out ACL, PCL, MCL, LCL

Apley's Distraction Test



- Tests for meniscal or ligamentous lesions
- (+) test is pain that is eliminated (meniscal injury), or pain that is increased (ligamentous)

Apley's Compression Test



- Tests for meniscal lesions
- (+) test is increased pain during compression which may increase with rotation in either direction

O'Donohue's Test

- Tests for meniscal tear or capsular irritation
- (+) test is increased pain, clicking, or popping in the joint line in either one or both flexion or extension during internal or external rotation

McMurray's Test

- Tests for meniscal injuries
 - Tibia IR
 - Indicates lateral meniscus injury
 - Tibia ER
 - Indicates medial meniscus injury
- (+) test is popping, clicking or locking of knee;
- pain or reproduction of symptoms

McMurray's Test

- Flex knee
- Rotate tibia on femur (external rotation for medial meniscus and visa versa)
- Extend knee
- Click and complaint
- Repeat
- Detects flap from meniscal tear



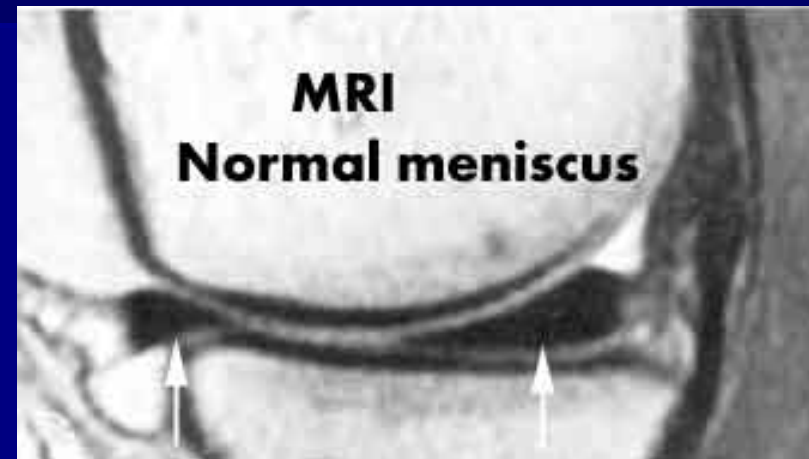
Stratford, et al 1995 & Corea, et al 1994 found McMurray missed 40% of meniscal injuries

Bounce Home Test

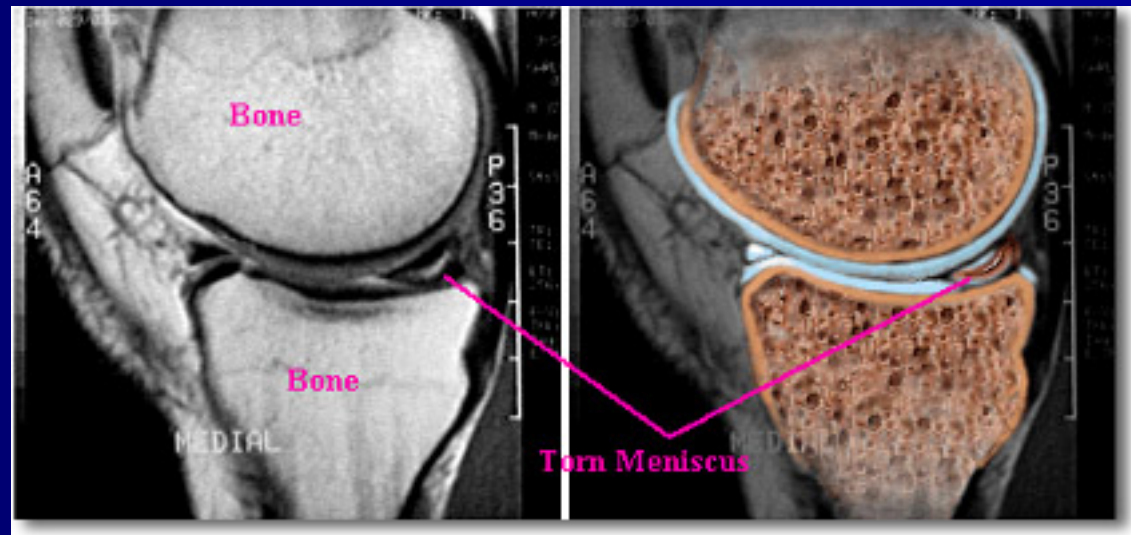
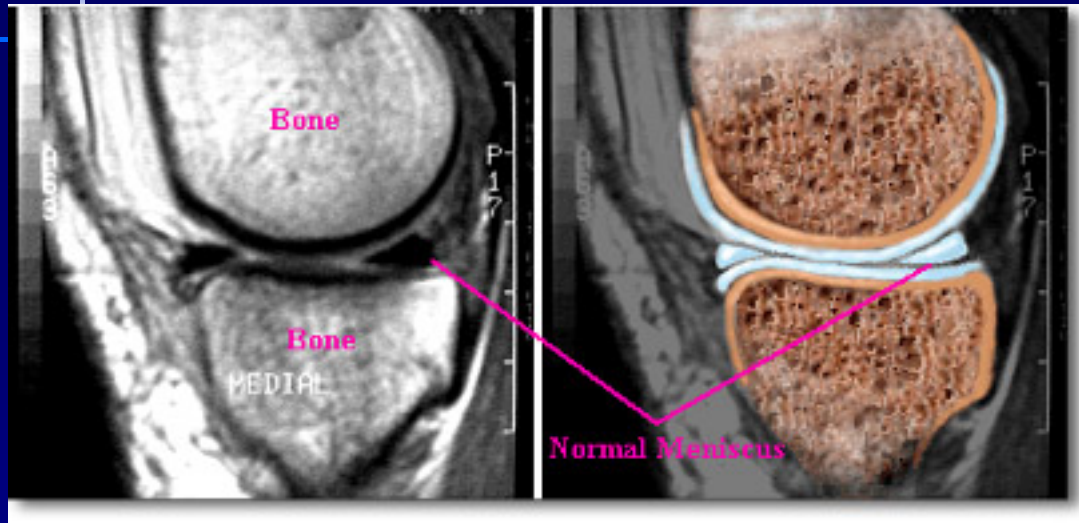
- Tests for meniscal tears
- (+) test is when extension is not complete or increased pain
 - Abnormal springy block at extension

Diagnostic Tools

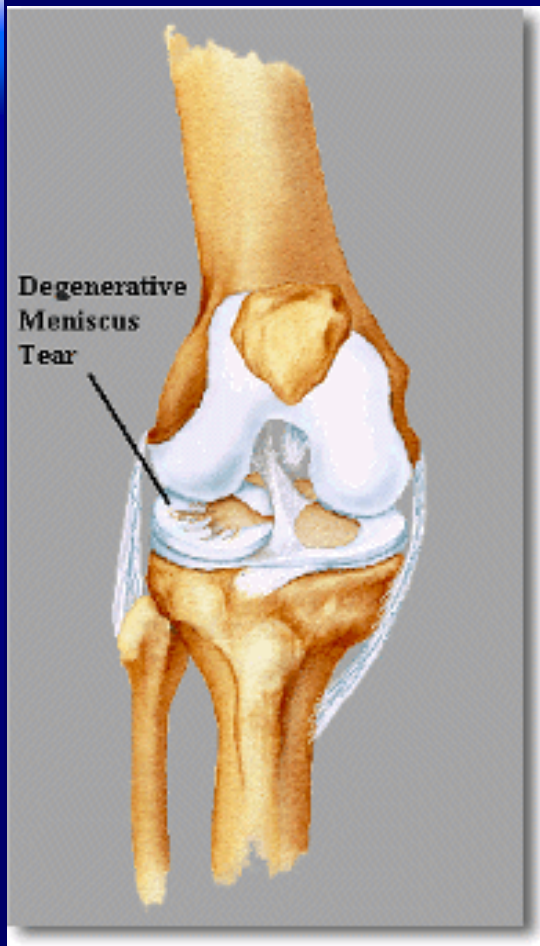
- Aspiration
- Radiologic Exam
- MRI
 - 90% accurate in diagnosing meniscal injury (Bernstein 2000)



Meniscal Injuries



Meniscal Tears



Radial Tear



Bucket Handle



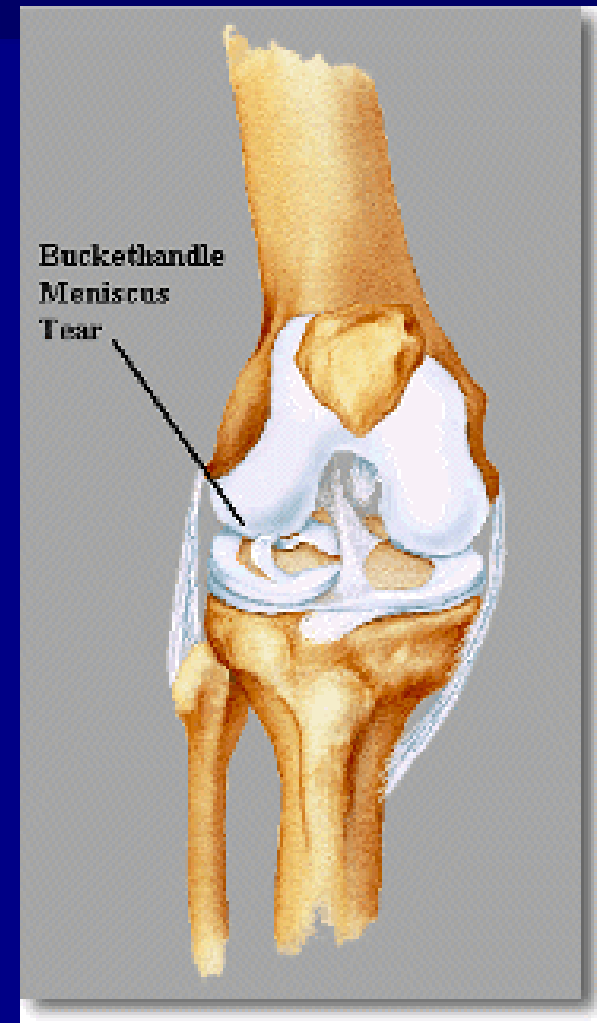
Parrot Beak



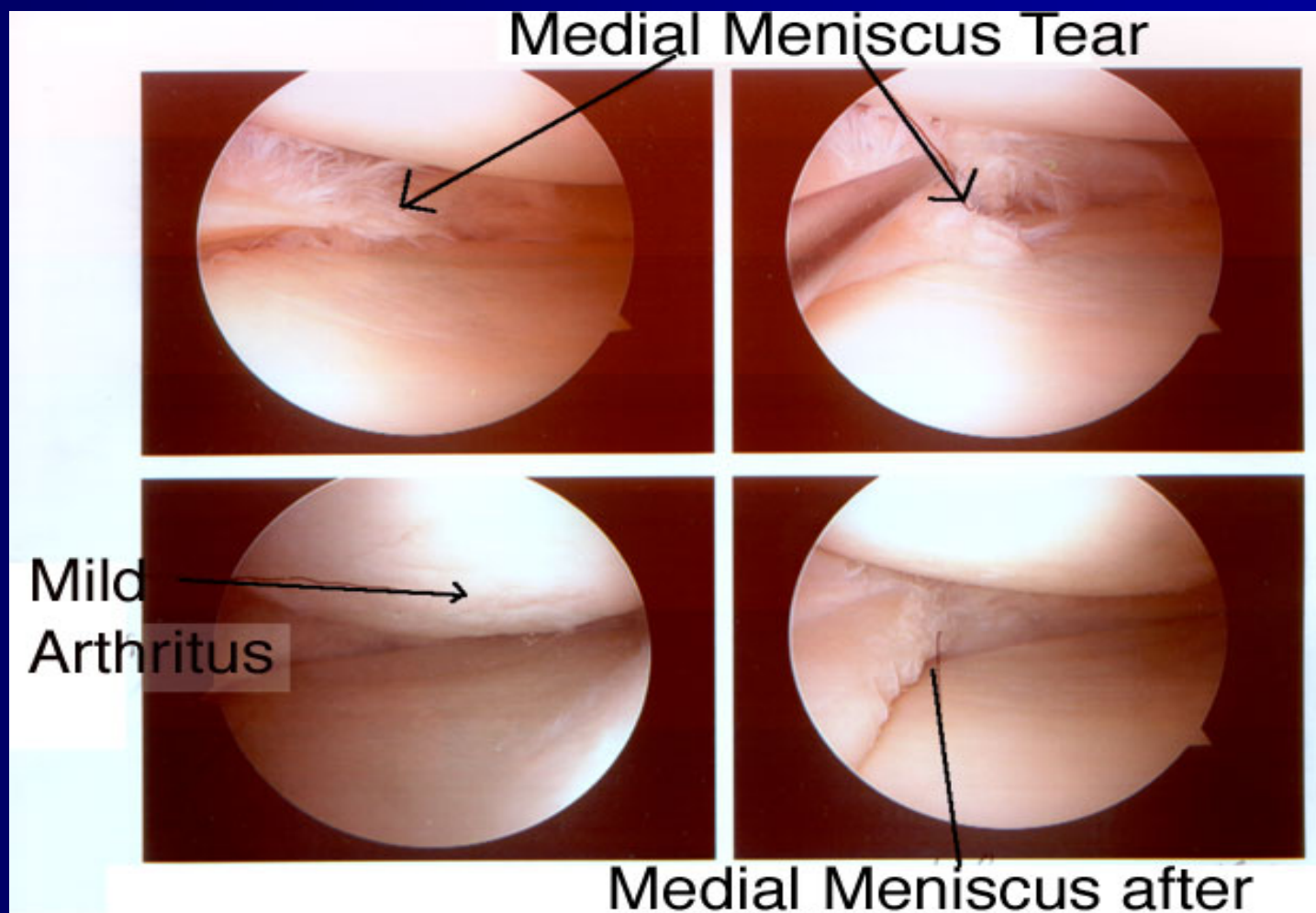
Longitudinal Tear

Bucket Handle Tears

- Long longitudinal tear
- Typically due to a CKC rotation
- Torn cartilage may fold and cause locking of the knee

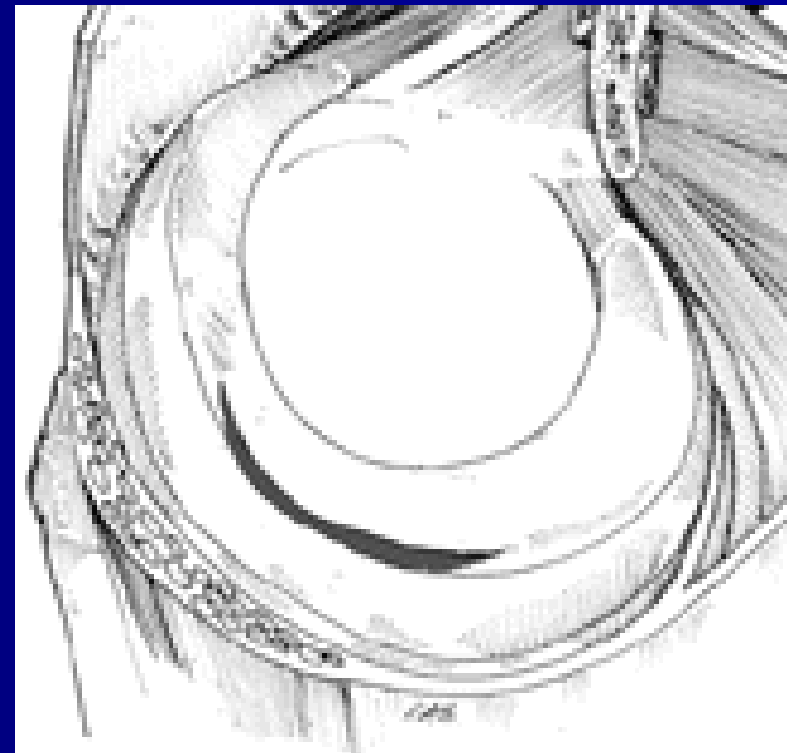


Arthroscopic View



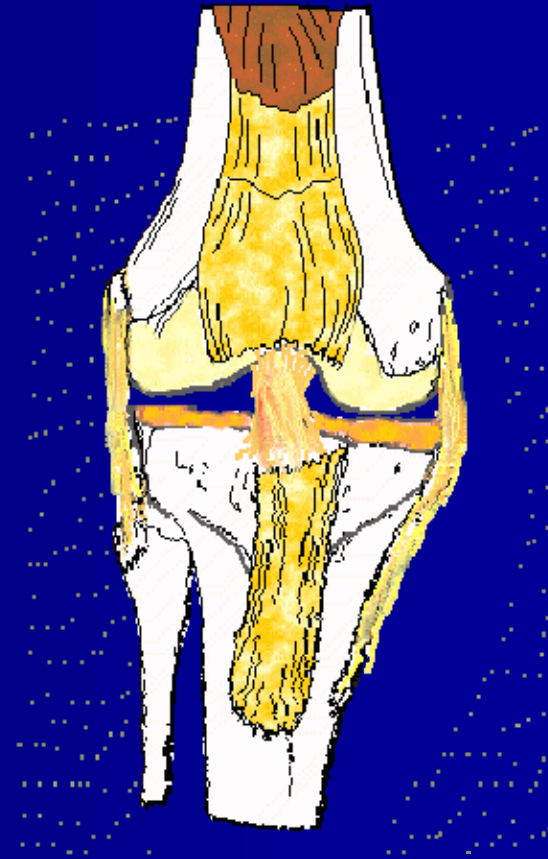
Red Zone Tear

- Peripheral meniscal tear in the zone of blood supply
- Outer 20% is vascular secondary to capsule & synovium
- White Zone is avascular “inner 2/3 of meniscus”



Unhappy Triad

- MCL, ACL, Medial Meniscus
 - O'Donahue
- MCL, ACL, and Lateral Meniscus
 - Shelbourne & Nitz 1991
- Typically due to a valgus force with the foot planted



PFJ Biomechanics

- During extension, patella glides cranially
- During flexion, patella glides caudally
- Patellar compression
 - OKC greatest at end range (final 30 degrees)
 - increases in CKC after 30 degrees of flexion



Patellofemoral Pain Syndrome

- General term to describe anterior knee pain
- Caused by a variety of factors:
- Signs & Symptoms:
 - Poorly localized P!
 - Theater sign
 - Little to no swelling
 - Pt. Tenderness under lateral patella
 - Insidious onset

Potential Causes of PFPS

- Weak Quads
- Poor VMO Timing
- Muscle Imbalance
- VMO Atrophy
- Tight Lateral Retinaculum
- Lax Medial Retinaculum
- Patella Alta / Baja
- Shallow Femoral Groove
- Increased Q-Angle
- Genu Valgus
- STJ Pronation
- Tight ITB / Quads
- Tight Hamstrings
- Trauma

Special Tests & Procedures

- Timing Test
- Medial Glide
- Patellar Apprehension
- Q Angle Measurement
- Ober Test
- Thomas Test
- Hip Flexor Contracture Test
- SLR Test
- 90/90 SLR Test
- Patellar Grind Test
- Plica Test(s)
- Release Sign
- Knee Extension MMT

Apprehension Test



- Tests for patellar subluxation or dislocation
- (+) test is verbal or facial apprehension from the athlete, OR an attempt to contract the quadriceps to avoid dislocation

Grind Test (Clarke's Test)

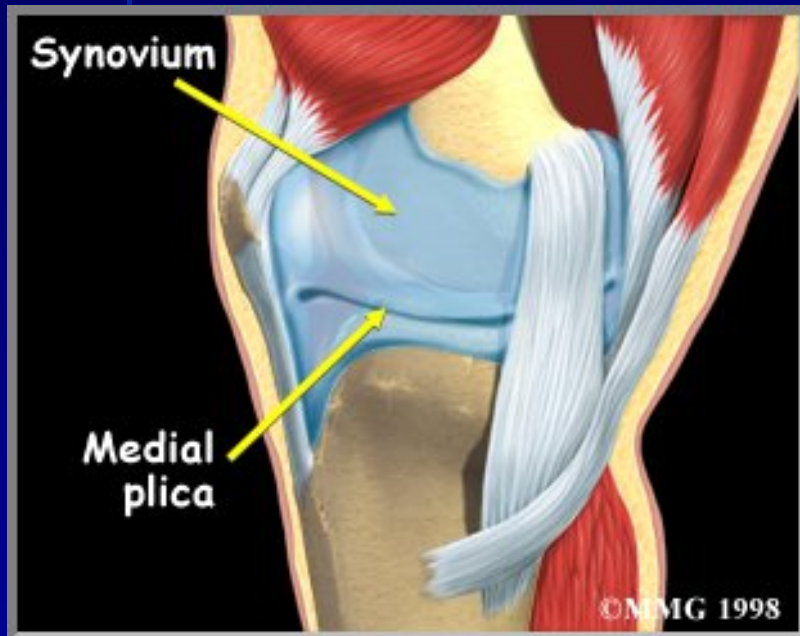
- Tests for patellofemoral pain
- (+) test is the athlete experiences increased pain, or cannot hold the contraction



Hughston's Plica Test

- Tests for medial plica's
- (+) test is pain and/or popping of the plical band under the clinician's fingers on the medial aspect of the knee

Plica Syndrome



- An anomaly or fold in the synovial membrane
 - Usually found along the anterior, superior medial border of the patella
- Only becomes symptomatic if inflamed or taut
- Signs & Symptoms:
 - Snapping, Clicking, or “jumping” of the patella during flexion
 - p! along medial border of the patella
 - Swelling
 - possible locking sensation

Radiographic Views:



AP & Lateral Views

Radiographic Views:



Lateral View

Radiographic Views:



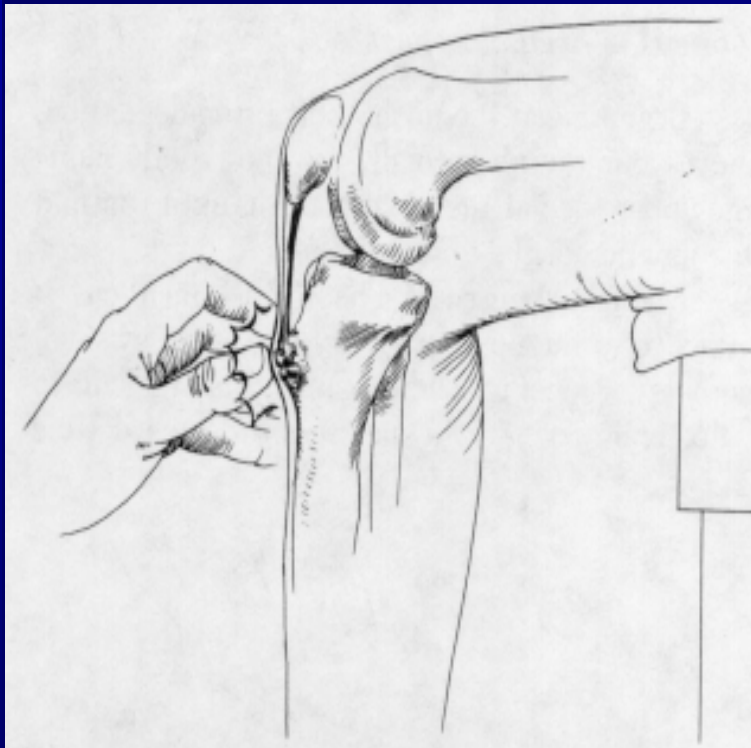
“Skyline” View

Patellar Tendinitis



- Typically occurs from overuse due to repetitive jumping
- Overloading of the extensor mechanism
 - causes microtearing and inflammation of the tendon
- S&S:
 - P!, inflammation, mild swelling, pt. Tenderness, crepitus
- Prolonged, chronic cases cause degeneration of the tendon

Osgood Schlatter's Disease



- Apophysis of the tibial tubercle
- Found in young athletes
 - Males more common
- S&S:
 - Anterior knee pain
 - Swelling
 - Tibial tuberosity pt. Tenderness
 - Increased tibial tuberosity prominence
 - C/o P! w/ k' extensions, squatting, kneeling & jumping

Sinding-Larsen-Johansson's Disease

- Apophysitis of the inferior pole of the patella (Similar to OSD)
- Commonly found in children ages 8 – 13 involved in running and jumping
- S&S:
 - Pain
 - Swelling
 - Point tenderness due to excessive strain on the inferior pole of the patella